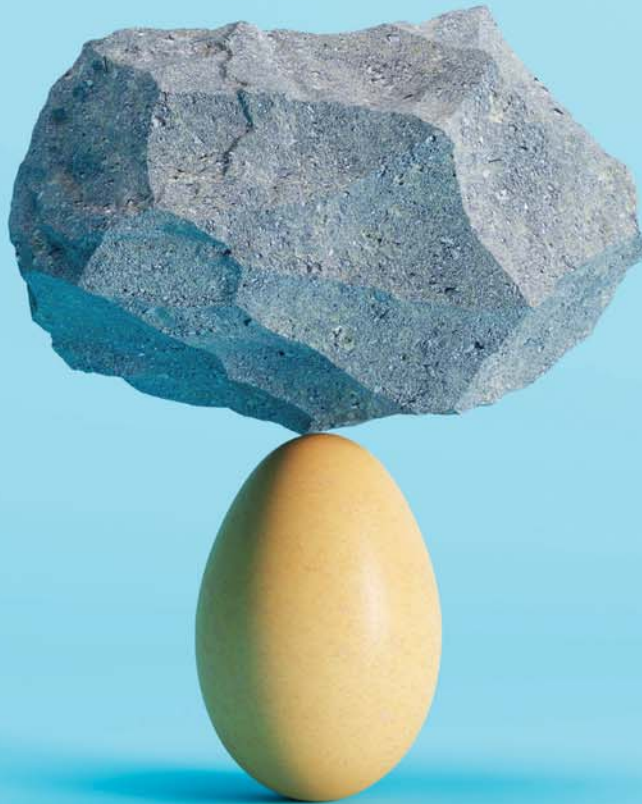

Encyclopedia of
Creativity

Edition

3



Volume

1

Mark A. Runco, Steven R. Pritzker



ENCYCLOPEDIA OF CREATIVITY

THIRD EDITION

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ENCYCLOPEDIA OF CREATIVITY

THIRD EDITION

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VOLUME 1



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PREFACE

The first two editions of *The Encyclopedia of Creativity* were enormously successful. They provided easily-accessible and trustworthy information about creativity and various topics related to creativity, such as innovation. The second edition, published in 2011, was named a 2012 *Outstanding Academic Title* by the American Library Association's Choice publication. The 3rd edition was inspired by the vast amount of new research about creativity. The field is expanding very rapidly. Much of this research is related to the increased complexity of each of our lives. Creativity helps each of us deal with such complexity. It also helps businesses, schools, and other organizations as the demands placed on them move faster and becomes more urgent. In addition, creativity provides new answers to such difficult problems as climate change, limited resources, religious and territorial conflicts, and poverty. For these reasons the *Encyclopedia of Creativity* includes articles that describe the creativity of individuals as well as organizations.

The *Encyclopedia* captures the full range of approaches to creativity. Creativity research is being conducted throughout the world in many different disciplines, including psychology, arts and humanities, health sciences, education, and business. The global interest is reflected in the number of authors throughout the world who have contributed to this edition as well as the topics covered.

Some countries such as China, Korea, Singapore and New Zealand have made understanding, teaching, and encouraging creativity part of their national goals. Europe proclaimed 2009 the year of creativity. The leaders of these countries recognize that their primary natural resource is the ability of their citizens and organizations to develop new products and innovative concepts. As competition becomes more and more intense, the business community in the United States is finally accepting the concept that creativity can contribute directly to the bottom line. A poll of CEOs in the United States by IBM's Institute for Business Value indicated that creativity is the most important characteristic being sought in new executive hires. We have responded to the increased interest in the business community by including more entries on organizational creativity.

The *Encyclopedia of Creativity* is designed to inspire further recognition of the personal as well as professional benefits that accrue from encouraging creativity. We know, for example, that individuals who are more creative are healthier and more adaptive, and in some instances may even have a longer life expectancy. We also know that many innovations and ways of solving problems have already led to incredible benefits, such as cures for diseases, improved technologies, and higher living standards for billions of people.

If we want a more creative world, then we must construct an environment that allows creativity to flourish. This requires knowledge that crosses disciplines. The increased quantity and diversity of research continues for the most part to be focused on a specific area of interest. Most scientific research is still released only in academic journals. There is still not a broad cross-fertilization of knowledge that enhances the development of new ideas. One of the axioms in creativity research is that breakthroughs often occur when information or concepts from one field are applied to a different one. Darwin's theory of evolution was partially inspired by his reading Malthus' theory of population growth and Lyell on geological change. Jean Piaget, noted developmental psychologist, borrowed heavily from biology and epistemology. Freud used a medical model to understand the psyche. Our hope is that readers will roam outside their usual areas of interest in a search for new ways of thinking. The comprehensive nature of the encyclopedia offers readers the opportunity to find new perspectives, which we hope will suggest fresh insights about themselves, their work, and their place in the world.

In the first edition we stated that there was enough known about creativity that it could be integrated into every level of our educational system. Unfortunately "teaching to the test" has become more prevalent in the United States while arts programs have been all too often dropped. We are obviously losing a great deal of the creative potential on this planet by leaving so many of our children uneducated and unable to cope with the

problems they face. The Encyclopedia continues to place an emphasis on education and cognition. It is our hope that teachers at the elementary and high school level will learn about their own creativity and how to value and encourage students. It is not always an easy task, but it can help enhance and even save the lives of some creative students who are at risk.

There has been some progress. The increased recognition of the importance of creativity in education was exemplified by its inclusion as number 8 in the top 20 competencies for teachers by the American Psychological Association. A 2019 Gallup poll in the United States reported that “Eighty-seven percent of teachers and 77% of parents agree that teaching approaches that inspire creativity in the learning process have a bigger payoff for students.”

Improvement is also evident at the college and post-graduate levels where courses in creativity are taught in many schools throughout the country. There is still a tremendous need for degree earning programs and specializations in creativity. The Torrance Center at The University of Georgia, Saybrook University, Buffalo State, and Drexel University are among the schools that currently allow a specialization in creativity studies. We hope that soon there will be many more universities and professional schools which include courses and specialties in creativity studies.

Audience

This Encyclopedia was designed for use by students of creativity, as well as researchers, teachers, scientists, coaches and consultants, architects and designers, trainers, managers, actors, writers, directors, painters and other individuals in the creative arts, inventors, therapists and other professionals who utilize creativity in their work. Anyone who is interested in learning more about their own creativity and the creative process can benefit from the articles presented here. None of this implies that there are quick and easy self-help answers - individual creative growth requires work, time, serious thought and a commitment to deeper understanding of the process. Still, creativity can be fun and it adds to the quality of life. Creativity can help us experience the highest levels of involvement in work and play that ultimately leads to great joy. Readers are encouraged to follow their own interests and inclinations in exploring these volumes.

Topics and Contents

Creativity is often viewed as a syndrome or complex. This perspective is described in various contributions to this volume, as are the various processes that are thought to make up or contribute to creativity. Other entries focus on particular methods and disciplinary approaches. In fact, one significant difference between this edition and the last one is that of sections devoted to the neurosciences and to technology and creativity. In addition, this edition is organized as a kind of hybrid, with overarching topics, including the two just mentioned, but also with various articles subsumed under Measurement and Personality headings. Specific topics include the following:

- There are reviews of a number of domain-specific areas, such as acting, dance, expressive arts, film, food, music, religion, science, sports, theater, and writing.
- Creativity and education are examined in articles about thought processes, such as developmental trends in creative abilities and potentials, the enhancement of creativity, intelligence, knowledge, play, prodigies, programs and courses, talent and teaching creativity.
- Cognitive aspects of creativity can be investigated in articles about altered and transitional states, analogies, attention, cognitive style, divergent thinking, flow and optimal experience, metacognition, metaphors, problem-finding, problem-solving, and remote associates.
- Those interested in business and organizational creativity can view articles about advertising with art creative visuals, business/management, creativity coaching, creativity exercises, entrepreneurship, group dynamics, innovation, leadership, organizational culture, organizational development, teams, and training, among others.
- Many articles examine the creative process across domains including areas such as discovery, emotion/affect, gender differences, incubation, inspiration, insight, novelty and paradigm shifts.

- The complex interrelationship between society and creativity is explicitly examined in articles about awards, conformity and conventionality, the creative sector and class of society, cultural diversity, the dark side of creativity, East vs. West, networking, social psychology, war, zeitgeist, and others.
- Personal and interpersonal creativity is discussed in articles relating to collaboration, family, life stages, mentors, networking, personal creativity and self-actualization.
- Because the encyclopedia focuses on scientific information about creativity, there are also articles that discuss concepts of creativity, definitions of creativity, expertise, longitudinal studies, researching art, artists and art audiences, research methods, phenomenology research and qualitative research.
- Articles which look at theoretical perspectives include behavioral approaches, chaos theory, componential models, economic perspectives, the evolving systems approach, the four P's of creativity, and implicit theories.
- The creative process is examined in contrarianism, climate for creativity, discovery, dreams, heuristics, invention, motivation/drive, multiple discovery, novelty, time and rewards.
- Mental and physical health and creativity are reviewed in mental health: affective disorders, health, mad genius controversy, schizophrenia and psychosis, stress, suicide, and transforming illness and visual art.
- Some subjects are grouped together in the Table of Contents. These clusters include the increasingly important Neurosciences and Technology, as well as Personality and Regional Creativity.

More than any other kind of book an encyclopedia is a collaborative effort. We thank our eminent panel of Subject Editors: Arthur Cropley, Vlad Glaveanu, Ning Hao, Maciej Karwowski, Aaron Kozbelt, Weihua Nui, Roni Reiter-Palmon, and Robert Weisberg.

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Figure 2 Flow

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Acting[☆]

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Actors in any capacity, artists of any stripe, are inspired by their curiosity, by their desire to explore all quarters of life, in light and in dark, and reflect what they find in their work. Artists instinctively want to reflect humanity, their own and each other's, in all its intermittent virtue and vitality, frailty and fallibility.

Tom Hiddleston, www.goodreads.com/quotes/tag/acting.

Acting is an ancient art form that has existed since the beginning of recorded time (Brockett, 1974). The Merriam-Webster dictionary defines “act” as the process of doing something, “acting” as the art or practice of representing a character on a stage or before cameras, and “actor” as one who acts in a play, movie, television show, etc. The process of acting involves the willingness of an individual to represent a character in order to tell a story. Highly trained and skilled actors embody the character so completely that the audience forgets that they are watching an actor portray a character. The story unfolds and the audience willingly suspends their disbelief as they witness the “reality” of the depicted story.

The revolutionary moment when acting was forever changed occurred when Thespis stepped away from the Greek chorus and proclaimed to the audience that he was the god, Dionysus. He was not only claiming to be someone else but he was also stating that he was a god. This decisive moment shaped how actors tell a story (Brockett, 1974). No longer did they merely report the myths or legends of the time, they now assumed the roles and gave life to the events of the story.

Acting is a complex topic that is influenced by cultural diversity, economic constraints, and lifespan demands. In this entry, topics include the creative process, in particular, character development, training criteria, memorization requirements, and the re-iterative gene-lore process. The challenges associated with talent identification, the collaborative nature of acting, and sustaining a career are outlined. Recent research findings in the fields of physiology, neurobiology, and psychology are incorporated to identify factors that are specific to actors and acting. Although not discussed directly, “Lady Luck” is always at play in the career of any actor. Synchronicity and spontaneity often guide the trajectory of an acting career as well as engaging in training and the creative process.

In order for acting to take place, a collaborative group of people are typically involved in a distributed creation of a new work (Sawyer and DeZutter, 2009). Some of the many members of this team include writers (playwrights and screen writers), directors, producers, artistic staff and designers (costume, lighting, sets, props, composers, choreographers), marketing and publicity personnel, technical directors, crew (backstage, front of house, camera operators, editors, sound technicians), talent agents and managers, and always the actors. Today, acting can be witnessed live in a myriad of venues (i.e., Broadway, concert halls, black box theaters, outdoor venues, comedy clubs, improv clubs) or digitally in the media arts (i.e., film, television, radio, Internet, mobile technologies, video games). Beyond the large number of people who are directly or indirectly involved in the creation of a performance, an even larger number of audience members view the event. According to the 2012 statistical data collected by the National Endowment for the

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Arts, the majority of the American population viewed a media product (i.e., television, radio, online platforms), 71% viewed acting as part of the Internet, and 45% attended at least one live theatrical event. In total, these figures surpass the 30.4% of the US population that attended an amateur or professional sporting event. Acting has a vast influence on daily life; even if viewers are unaware they are witnessing acting (i.e., commercial advertising, reality media programming, docudrama).

Creative Process and Acting

Actors are regarded as creative artists in their own right; however, they are also interpretive artists. They must give life to a script, further the action of the plot, and remain faithful to the character they are portraying. The majority of actors are highly trained, often within recognized acting systems (Hodge, 2000). They must train their body, their voice, and their emotional expressivity in order to inhabit the role of a character. As well, they develop powerful memory retention skills. In order to enhance memorization skills, actors learn to converge visual and linguistic feedback (Palmiero et al., 2010). The combination of physical posture and gesture, vocal intonation and enunciation, entering intense emotional states and transforming these states, and actively listening and responding to other actors and the audience are all operational in every moment that an actor is performing. The goal is to integrate and inhabit these elements without conveying to the audience any of these variables. Actors must also remain faithful to the text and the intention of the writer, while affirming their commitment to the portrayal of the character and sustaining immediacy with the text, the other actors, and the audience (Hodge, 2000).

The creative process in acting involves several phases that generally remain consistent, although it may vary slightly depending on the medium and project. Often described with slight wording variations, the three phases include the initial interaction with the project, the script, and sometimes the cast, followed by a rehearsal phase that may vary in length, and finally, the performance phase. The rehearsal phase involves the most complex process. The character must be understood and personalized, including outlining character objectives, needs, actions, and trajectory. The text must be analyzed and memorized and the character must be embodied (vocally and physically). Stage or camera blocking (pathways and focus) must be established and scenes must be organized and directed. During the rehearsal process creative engagement by all involved is essential.

The creative team, including the actors, participates in the geneplore model of creativity. This two-phase creative model involves a reiterative process of shifting between the generative phase where new ideas emerge from memory retrieval, mental synthesis, and transformation and the exploratory phase that involves an analysis, appraisal, and modification of ideas that are generated (Sternberg, 2005). This creative process may occur in only a few rehearsals or persist for a protracted period of time such as during the creation of new shows that will eventually be produced and performed on Broadway. What remains unique in acting is that the geneplore creative process occurs both individually within the actor and distributed collaboratively amongst the many participants involved in creating the production (Sawyer and DeZutter, 2009).

In the acting studio or rehearsal hall, creativity is enhanced when there is a mixture of structured and unstructured activities (Sowden et al., 2015), such as when a scene is analyzed followed by a brief unstructured improvisational exploration. The combination of both processes promotes cognitive fluency, originality, divergent thinking, self-confidence, and motor creativity (Sowden et al., 2015). Because acting is a collaborative art form, members of the team share their observations and offer suggestions. Critical appraisal becomes a constraint and a source of inspiration (Gibson and Mumford, 2013). The collective ability to examine the work that is emerging furthers the generative and exploratory creative process. In order to manage self- and other-evaluations, a sense of trust and compassion must be nurtured in the studio and rehearsal hall (Seton, 2010). Without these two factors, creativity is dampened while trait and state shame-prone withdrawal and ruminative self-criticism may escalate (García et al., 2017).

Identifying and Developing Acting Talent

Actors frequently remember a childhood that was filled with imitating others, role-playing popular characters, and creating imaginary worlds (Goldstein and Winner, 2009). These activities may be the fertile ground that nourishes absorption, persistence, discovery, and synthesis; all components of creativity. Young actors also demonstrate a natural talent to memorize texts and acquire a growing awareness of the impulses and intentions of others, in particular, for the characters that confront obstacles within the imaginary scenes they create or the scenes that they have memorized (Goldstein and Winner, 2009). During these early explorations in acting, the young actors also acquire a stronger theory of mind (awareness that the other has a separate mind), as well as a more empathic understanding of the suffering of others (Nettle, 2006). Many actors pursue a career in acting despite a lack of parental support or understanding (Goldstein and Winner, 2009; Kogan and Kangas, 2006). Their early interests inform their later career aspirations, including seeking training at an older age in order to realize their goals (Rasmussen and Rasmussen, 2015).

Actor training must include educating the imagination, especially training skills to sustain mental and emotional imagery (Hodge, 2000). Regardless of the actor tradition (i.e., Stanislavski, Hagen, Suzuki, Bogart, Meisner), actors are trained to explore their imagination, generate novel ideas, probe their emotional or sense memories, and investigate embodied processes related to the character and the circumstances that the character experiences (Hodge, 2000). In order to meet the intense physical and emotional range of many characters, actors must cultivate physical, vocal, and psychological skills. Emotional states are expressed through vocal intonation, tempo, pitch, loudness, articulation, and vocal quality. Actors learn to project and modulate their voices to enliven emotional expressivity; without years of vocal training actors are vulnerable to vocal disorders which can shorten or

compromise their careers (Master et al., 2008; Walzak et al., 2008). Movement classes, martial arts, stage combat, alignment work (i.e., Alexander Technique), and improvisation all enhance physical expression, and dramatic intention is developed in script analyses, improvisation, and scene work classes. Often during acting training, especially during script analyses and actively embodying the character, actors learn to empathize with the character to be performed (Hodge, 2000). They must remove personal moral judgment and embrace all that has influenced the character.

In all training settings, student actors are profoundly influenced by positive and negative teaching methods and by the ethical practices that operate in the training organizations (Seton, 2010). Some of the key positive factors that enhance actor training include an environment that fosters trust, respect, freedom, challenge, collaboration, and clarity (Seton, 2010). Cultivating an ethically respectful environment is even more vital given the reality that many actors enter formal training much later than musicians or dancers; in part, because actor training requires a complex multidimensional approach necessary to portray complicated characters who exist in adverse situations; this frequently requires more developmental maturity (Kogan and Kangas, 2006). Generally, acting programs are effective in this training; however, there are currently too many highly trained actors given the limited professional opportunities (Wilkie, 2015). In an effort to ameliorate this situation it has been proposed that curriculum in acting training programs now include courses in psychological self-regulation and entrepreneurial skills that can extend beyond an acting career (Wilkie, 2015).

Physiologic and Neurological Demands of Acting

The demand of embodying a character involves the actor's neurological and physiologic systems. The complex vocal, physical, and emotional requirements of acting are reflected in the biology of the actor. For example, actors exhibit higher physiologic responses when expressing emotional states of the character compared to untrained performers (Pelletier et al., 2003). Their heart rate and autonomic (sympathetic) nervous system responses are intensified when they express anger, disgust, fear, and happiness. Neurologically, actors have more integration in the vocal-motor and sensorimotor neural networks. Through training, actors can discriminate and decode pitch in verbal discourse and they can differentiate task-relevant and task-irrelevant auditory and visual signals (Pelletier et al., 2003). They develop auditory-motor expertise. Because they also express a full range of heightened emotions, they rapidly access emotional neural circuits that are integrated in the implicit motor neural circuit and the subcortical and cortical regulatory networks (Pelletier et al., 2003).

Vocal training also provides unique physiologic changes in actors. Compared to untrained actors, professional actors demonstrate greater vocal fitness and enhanced respiratory capacity. They also have lower pitch as a result of vocal training (Master et al., 2015). In addition, language and action are more deeply integrated within the cortical and subcortical regions of the brain (Pelletier et al., 2003). In part, this is related to the complex vocal, physical, and emotional training, as well as the constant demands to memorize large quantities of dialogue. In addition, greater integration is evidenced in regions in the brain responsible for attention, attentional shifting, and social-emotional understanding (Pelletier et al., 2003).

Psychological Elements

Personality studies that examine actors reveal a wide range of traits, which are often contradictory. For example, actors manifest greater extraversion, openness to experience, adventurousness, expressiveness, agreeableness, dogmatic behavior, aggressiveness, impulsiveness, sensation seeking, ambition, reflective thinking, mystical beliefs, risk-taking, irresponsibility, neuroticism, and guilt-proneness (Kogan and Kangas, 2006; Nettle, 2006). Beyond personality investigations, studies have demonstrated that actors have a greater family history of mental illness and addiction (Baker, 2008). As well, the unpredictable nature of an acting career is often associated with increased incidences of illness, including substance abuse and stress related illnesses (depression and anxiety). For example, in Great Britain, actors were classified as the third highest profession to die from these disorders (Baker, 2008).

When portraying a character, many actors experience a blurring of the character's identity with their own identity. Despite excellent training, the actor inevitably experiences the visceral life of the character, even if it is for brief moments during a performance (Burgoyne et al., 1999). Self-perceptions are altered during the course of a performance, and even more so during long performance seasons. For many actors, they experience greater empathy and social cognition for their character (Nettle, 2006), which may intensify identity boundary blurring. As well, actors tend to employ more dissociative processes (absorption and compartmentalizing), which increase potential character boundary blurring (Thomson and Jaque, 2011). Actors also experience more unresolved mourning for past trauma and loss experiences, in part, because they continually draw from these experiences when portraying characters (Thomson and Jaque, 2012). Adding to this tendency to merge with the creative work, audience members also confuse the character's personality with the actor's personality (Tal-Or and Papirman, 2007). Audience attribution errors may increase distress in the actor, including fearing that their personality identity is not stable.

For some actors, there is a tension between their moral values and those of the character, and yet they must sublimate their own moral abhorrence in an effort to portray the character without judgment (Hodge, 2000). It is the task of the audience to determine a moral stance related to the actions of a character. This is ultimately the goal of good storytelling. Developing a performance work that can shape or change the moral values of an audience is inherent within many productions. This was demonstrated in a research study that investigated the effects of musical theater and how it changed audience's attitudes (Heide et al., 2012). Likewise, students

who are exposed to theatrical productions frequently exhibit greater academic achievement and future career success (Catterall et al., 2012). They are able to internalize how characters face conflict and seek solutions.

Child actors present with added psychological complications. They often spend long hours on film or television sets or in rehearsal halls and theaters. They are exposed to public scrutiny, which may intensify identity confusion, especially when audiences misattribute the character's personality with the child (Tal-Or and Papirman, 2007). Parent-child relationships are altered including the reality that the child actor is frequently removed from the complexity of a nurturing family environment (Anderson, 2011). These young actors are at increased risk of developing a weaker self-concept and poorer emotional regulation (Anderson, 2011).

Regardless of the age of actors, when they are required to perform traumatic testimonial-based material, many are troubled by past trauma or vicarious trauma-related symptoms (Thomson and Jaque, 2011). Effective acting training offers tactics to navigate this difficult material. For example, actors are encouraged to implement higher cognitive processing as well as reduce their tendency to personalize the traumatic material. Distancing emotionally from the character must be encouraged during rehearsals and following performances (Burgoyne et al., 1999; Thomson and Jaque, 2017). As well, adopting a positive stance regarding the inherent meaning contained within the creative work supports a sense of self-efficacy, meaning, and resilience.

Sustaining a Creative Career in Acting

Social influences (i.e., social support, talent mentoring) can undermine or enhance an actor's performance and career trajectory (Nettle, 2006). As well, the demand of the production influences the mood and self-efficacy of actors. Actor personalities also influence project preferences; actors who seek high-risk activities are typically drawn to more action-based works whereas introverted actors may explore more emotionally dark pieces. These career choices are based on mood-congruent selections (Wilhelm et al., 2004). Another factor that encourages a career in acting is the positive rewards during flow states. Many actors, and their audiences, recognize these transformative states, especially when the challenge of the work is met with adequate skills and the feedback during the performance is unambiguous and direct (Robb and Davies, 2015). Whether actors work continuously or intermittently, their career satisfaction is much greater than their job stress (Wilhelm et al., 2004). They value opportunities to explore new works, including experiencing a sense of autonomy and self-determination.

Conclusion

Acting is a creative process that integrates multiple factors. It requires substantial training and preparation in order for actors to work with a sense of spontaneity. Acting is also a collaborative art form. The creative process of acting requires actors to strongly engage with the text, other actors, directors, designers, and crew (media or theater). Historically, Stanislavski is recognized as a titan in the field; he changed the landscape of acting, including what an audience expects from a performance. Today, it is understood that actors must portray an authentic character, one that is always emotionally and physically engaged. The immediacy of acting necessitates that the actor is "present" in every moment. This tradition actually was born when Thespis courageously stepped away from the Greek chorus to assume the role of Dionysus. The Greek audience also joined in this mercurial creative process; they "believed" that Thespis was Dionysus. This same delicate process continues. The creative process of acting is rooted in the power to give life to characters and share stories and situations experienced by these characters. Actors and audiences collectively join in this process, one that enriches all our lives.

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ADHD & Autism Spectrum Disorder

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Glossary

Conceptual Expansion A type of creative thinking that involves loosening the structure and definition of acquired concepts.

Divergent Thinking A type of creative thinking that involves generating multiple ideas or solutions from a single starting point.

Enhanced Perceptual Processing (EPF) EPF is an account of the enhanced perceptual processing in individuals with ASD; according to EPF theory, individuals with ASD have superior low-level perceptual operations and representations.

Inhibitory Control An executive control process that enables one to suppress or regulate prepotent (i.e., strong or automatic) responses to stimuli; enables one to focus on relevant stimuli in the presence of irrelevant stimuli.

Savant/Savant Syndrome A savant (individual with savant syndrome) is someone with general cognitive impairments but exceptional ability in a domain such as music, drawing, or calculation.

Repetitive Transcranial Magnetic Stimulation (rTMS) TMS is repetitive non-invasive stimulation of the brain. An electromagnetic coil is placed on the scalp to deliver an electric current to a specified region of the brain leading to either increased or decreased activity in the targeted region.

Underconnectivity Hypothesis The underconnectivity hypothesis proposes that underconnectivity between posterior and anterior brain areas may underlie ASD symptoms.

Weak Central Coherence (WCC) WCC is an account of the enhanced perceptual processing in individuals; according to WCC theory, individuals with ASD have a deficit in global processing that leads to greater focus on low-level perceptual information.

Introduction

Attention Deficit Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD) begin in early childhood and persist into adulthood. They have neurological bases and distinct profiles, but do share certain cognitive characteristics such as attentional impairment. In addition, studies suggest that both of these developmental conditions may be associated with enhanced creativity. However, this manifests differently in each population.

The evaluation of creativity, creative cognition and achievement in ADHD and ASD individuals is highly variable between studies, which may contribute to the mixed findings in the empirical literature. Measures include assessments of actual (real-world) creative achievement, laboratory design tasks (e.g., inventing new toys, product labels, or cell phone features), creative activities such as collage making or storytelling, and standardized measures of creative ability, such as the Torrance Test of Creative Thinking, or TTCT.

The TTCT emphasizes divergent thinking; a mode of cognition marked by expansive thought and the generation of multiple ideas or solutions, and includes verbal activities (e.g., list possible outcomes in a hypothetical situation) and figural/visual activities (e.g., drawing multiple pictures from a simple shape or line). Similarly, the unusual (or alternate) uses task requires one to list multiple possible uses for a common object such as brick. Divergent thinking tests are typically scored for: fluency

(number of responses), originality (uniqueness of responses), flexibility (categorical fluency or shifts), and elaboration (level of detail). Standardized tests like the TTCT also yield a composite score and optional scoring for creativity indicators such as richness of imagery, emotion, and fantasy. The latter dimensions may be more sensitive to individual differences than global or composite indices.

Other aspects of creative cognition, such as conceptual expansion, have been evaluated using tasks borrowed from mainstream creativity research. Overall, the diversity of methods reflects a trend toward a more fine-grained analysis of creative strengths in ADHD and ASD, rather than global assessment of creative ability or performance.

Attention Deficit Hyperactivity Disorder

ADHD is a complex disorder, characterized by irregularities in attention, impulse control, and motor activity, which begins in childhood and persists into adulthood. For many individuals with this condition, ADHD creates difficulties in school, work, and social situations. Yet, a growing body of evidence suggests that individuals with ADHD may also be exceptionally creative. Hints of an ADHD-creativity connection arose in the 1970s, when children diagnosed as ‘hyperkinetic’ were evaluated by researchers at the Foundation for Gifted and Creative Children. The children had been referred to the clinic by their parents, who were concerned that educators were mistaking the children’s creative behavior for hyperactivity. The evaluation of this particular group of children showed them to be similar in creativity to children referred to the clinic for reasons other than disruptive behavior. Yet, anecdotal reports of higher creativity among ADHD children continued to surface, and these inspired empirical investigations.

Creativity in Children With ADHD

Early studies of the ADHD-creativity connection compared gifted (high IQ) children with ADHD and their non-ADHD/high IQ peers on standardized measures of creative ability. This research found higher overall creativity, originality, and flexibility for children with ADHD, relative to non-ADHD children, on visual activities. Moreover, the creativity of the ADHD children was linked to their ability to incorporate peripheral environmental information into their figural creations. Among children of average intelligence, those with ADHD performed similarly to non-ADHD children on standardized measures of creativity, which led to speculation that high intelligence was necessary to enable children with ADHD to use poorly filtered information for creative purposes. Yet, later studies of average-intelligence children revealed ADHD-related creative strengths in specific qualitative dimensions of visual creativity, such as expressiveness of ideas and richness of imagery. Similar findings have been reported in research of creative storytelling: children with ADHD told stories that were higher in originality and elements of fantasy—yet shorter (lower fluency)—compared to children without ADHD. Children with average intelligence and ADHD also show selective advantages in creative generation tasks. In one such study, children with ADHD demonstrated higher novelty on a toy invention task relative to their non-ADHD peers (Abraham et al., 2006).

Children with ADHD share a number of traits with children who are intellectually and/or creatively gifted; characteristics ascribed to both groups include high energy, curiosity, artistic, impulsive, hyperactive, and argumentative. Teachers may be more likely to label creative children as disruptive and inattentive, and children who are highly creative may be misdiagnosed as ADHD. At the same time, a child may be both gifted and diagnosed with ADHD. The question of whether children with ADHD are more creative than non-ADHD peers is not straightforward, and findings are mixed. Overall, studies of children suggest that ADHD is positively linked to specific aspects of creative thinking, such as originality and expressiveness of ideas (See Children’s Creativity).

Creativity in Adults With ADHD

In recent years, the scope of research has expanded to encompass adults with ADHD. Generally speaking, adults and children with ADHD show a similar pattern of creative strengths. In studies of college students, those with ADHD show higher originality than non-ADHD peers on divergent thinking tests (unusual uses task) as well as realistic creative design tasks (White and Shah, 2016). College students with ADHD also demonstrate selective advantages on aspects of standardized creativity tests; in particular, ADHD is associated with higher originality, expressiveness of ideas, richness of imagery, and elements of fantasy. Like children with ADHD, adults also show lower conformity to task examples in creative generation tasks; and, adults with ADHD are less constrained by prior knowledge on tasks of conceptual expansion.

Adults with ADHD may have a more chaotic creative approach than non-ADHD adults, as evidenced by a relatively high preference for the idea generation stage of creative problem solving and a tendency toward divergent, original thinking (White and Shah, 2011). In contrast, non-ADHD individuals may be more likely to engage in structured creative cognition. For example, if asked to invent an animal or fruit that might exist on another planet, most people would start by thinking of a typical animal or fruit on Earth and then modify it somewhat into an “alien” version. An artifact of this process of structured imagination is persistence of features of the inspiration in the creative product; as a result, the creation may be lower in novelty and originality. Likewise, imagination may be limited by the imposition of categorical regularities; for instance, a person creating an alien creature might include the property of bilateral symmetry, as this is typical of animals on Earth. Studies have shown that adults with ADHD are less likely to be constrained

by recently presented and prior knowledge during creative generation. Moreover, adults with ADHD are more likely to engage in conceptual expansion—the process of extending categorical boundaries and conceptual structure— compared to non-ADHD adults (White, 2018).

Explanatory Models of Creative Cognition in ADHD

Several candidates have been proposed to account for the higher creative cognition observed in children and adults with ADHD. Most notably, these include the core features of ADHD; distractibility and poor inhibitory control. ADHD-related distractibility has been linked to functional irregularities in the default-mode network (DMN), a set of neural pathways and structures that are more active when the brain is not occupied by a goal-oriented task. During focused activity, the DMN is suppressed. Symptoms of ADHD have been linked to interference from the DMN, which has also been dubbed the ‘imagination network.’ In particular, distractibility has been cited as a factor in reduced susceptibility to the constraining effects of knowledge during creative generation observed for children and adults with ADHD.

Low inhibitory control has been linked to original, divergent thinking in non-ADHD individuals, and is likely a contributing factor to ADHD-related creative cognition as well. A primary task of inhibitory control is to restrict the flow of excess and/or potentially interfering information into working memory; therefore, an abundance of information - such as might arise when the gating mechanism is inefficient - could potentially yield fruitful and unexpected combinations.

Evidence for this comes from studies of gifted children with ADHD, which linked visual divergent thinking in ADHD children to their use of peripheral information from the environment for creative purposes (Shaw, 1992). Studies of college students with ADHD also demonstrated a link between poor inhibitory control and higher original thinking among individuals with ADHD (White and Shah, 2006). Low inhibition is also likely to be a factor in the wide semantic activation and breadth of attention observed in adults with ADHD, which have been linked to higher flexibility in realistic creative design activities. Poor inhibitory control may play a role in the lesser constraints of knowledge in ADHD, and the resultant conceptual expansion observed for individuals with ADHD.

In addition to the cognitive processes described above, motivation may also be relevant to creative cognition in ADHD. Models of behavioral dysregulation in ADHD posit irregularities in motivational and reward pathways of the brain. Yet, individuals with ADHD show heightened sensitivity to reward and greater interference control in rewarding contexts. Intuitively, individuals with ADHD should be expected to be most creative when both intrinsically and extrinsically motivated. This hypothesis is supported empirically by findings of higher originality for ADHD students, relative to non-ADHD peers, under reward-seeking conditions (Boot et al., 2017). Personality traits, such as novelty-seeking and openness to experience, may also contribute to real-world creative behavior in individuals with ADHD (See Motivation).

Practical Implications & Creativity in Real-World Contexts

The creative cognition observed in laboratory studies of individuals with ADHD may have real-world implications, as well. When individuals look to a prior model for inspiration, they may become stuck: designers refer to this as “fixation.” Over-reliance on task examples and prior knowledge reduced originality of creative products, yet individuals with ADHD are less constrained by task examples and prior knowledge on creative generation tasks such as invention of new toys or product labels. The creative ideas of individuals with ADHD may thus be less likely to conform to previous models and more likely to thwart conventional structure and expectation.

Creative cognition is predictive of actual creative achievement, which bodes well for the possibility that the creativity of ADHD individuals in the laboratory will manifest in real-world creative behavior. In fact, studies found higher levels of self-reported creative achievement for college students with ADHD compared to non-ADHD students— especially for those domains which aligned with expressed interests. In other research, adults with ADHD endorsed relatively high preference for idea generation in a creative style inventory; taken together, findings suggest that people with ADHD might excel in fields that emphasize brainstorming and creative ideation. ADHD symptoms of impulsivity and hyperactivity were positively correlated with entrepreneurial orientation and intention— and may be a factor in entrepreneurial firm success. ADHD characteristics such as risk-taking may play a role in the success of adults with ADHD in enterprising contexts such as small business startups.

Summary of Creativity in ADHD

Overall, there is growing empirical support for anecdotal claims of a connection between ADHD and creativity. In particular, ADHD may be associated with original, divergent thinking; and, there is some evidence that this may translate into real-world creative behavior. Findings of higher creativity related to ADHD have been more consistently found in studies of high-functioning individuals, such as gifted children and college students. Further research is necessary to determine the precise nature of the relationship between ADHD and creativity, and to identify the factors which may promote the success of individuals with ADHD in real-world creative endeavors.

Autism Spectrum Disorder

Autism spectrum disorder (ASD) is a developmental condition that is associated with impaired communication and behavior. Specifically, individuals with autism have challenges communicating and interacting with others. They sometimes display unusual or repetitive behaviors. Furthermore, they often have highly restricted interests in certain domains like numbers or art. ASD is also associated with some cognitive strengths in that people with ASD encode and remember visual and auditory information with precision.

Empirical Studies of Creativity in ASD

Research on creativity in ASD is mixed, with individuals that have ASD often showing lower or equivalent levels of verbal divergent thinking on the unusual uses task and standardized measures, such as the TTCT, compared to the general population. On figural divergent thinking tasks, however, individuals with ASD may create drawings higher in originality and elaboration, relative to non-ASD peers. Yet, ASD participants may score lower in flexibility, because they frequently draw figures associated with their primary interests (Liu et al., 2011). In another study, amongst a non-clinical sample, autistic traits were associated with lower fluency and higher originality of divergent thinking (Best et al., 2015). Across these studies, it seems that individuals with ASD may approach tasks of this sort with a more narrow focus on a few domains of interest, and thus show lower fluency and flexibility; at the same time, they elaborate upon each idea generated and many of these ideas are original relative to the general population.

Savant Syndrome and Creative Talent

Despite the lack of evidence for higher creativity on standardized measures, some individuals with ASD show great talent in creative domains such as the visual and performing arts. Indeed, a well-known phenomenon is that of the savant, who may have ASD but also shows special talent in a specific domain. Stephen Wiltshire, for example, is an artist with ASD from the UK made famous by television specials and as one of the subjects in Oliver Sacks' book *An Anthropologist on Mars*. He creates extremely detailed and precise drawings of scenes he has only glanced at briefly; his impressive drawings sell for huge sums and are included in museums and private collections. At the same time, he learned to speak very late in childhood and has substantial deficits in communication, social skills, and cognition. Derek Paravicini is a savant musician but shares traits with Stephen Wiltshire. Just as Wiltshire can briefly view a scene and reproduce it from memory, Paravicini can listen to a musical piece a single time and play it from memory.

The prevalence of savant skills is unclear, in part because of lack of a clear definition of savant. Prodigious talent such as displayed by Wiltshire and Paravicini is rather rare, with perhaps as few as 100 such individuals worldwide who are known to researchers. At the same time, up to 10% of individuals with ASD have some savant abilities that stand out. Estimates for the proportion of ASD individuals who show some special talent (at least relative to their own general skills) is even higher. One study found that as many as 70% of individuals with ASD had some unusual individual skill. Some of the skills reported in that study included calendar calculation, mathematics, and memory. However, 17% showed special talent in drawing and another 17% in music. Another recent study found that parent ratings of autistic traits in children were correlated with ratings of talent. Furthermore, there is an overlap between genes associated with autistic tendencies and genes associated with "talent." Note, however, that this more common "special talent" does not reach a savant-level ability. Furthermore, it is perhaps in the eye of the beholder whether or not these talents lead to truly original products (as opposed to mere mimicking); the selection of subjects, for example, may be unique.

Explanatory Models of Creativity in ASD

There are several possible explanations for the potential creative strengths of individuals with ASD. Two prominent accounts focus on the perceptual processing of individuals with ASD, including the "Enhanced Perceptual Functioning" or EPF theory of Motttron et al. (2009) and the "Weak Central Coherence" or WCC theory of Happé and Frith (2006). Both theories are based on the relative emphasis on lower-level perceptual features/local processing compared to higher-level features/global processing. However, they differ in the extent to which they attribute this bias to superior perceptual processing versus a deficit in higher-level processing. These approaches also differ in terms of the assumptions regarding the underlying neural basis of ASD processing differences and the role of early experience. For example, hypersensitivity to sensory information may impact the development of perceptual representations.

Regardless, there is a great deal of evidence for the local versus global advantage in ASD. On tasks in which global information may interfere with local (such as on the block design task of the Wechsler Adult Intelligence Scale), ASD individuals do better than non-ASD individuals. Likewise, ASD individuals are better at recognizing and copying "impossible" figures and finding "hidden" figures in the Embedded Figures task. Lower-level perceptual and attention tasks also show preference for local processing; ASD individuals, for example, are faster at visual search tasks and less affected by distractors than non-ASD individuals.

One neural explanation for enhanced lower-level perceptual processing and emphasis on local features over global form is lower connectivity across brain regions (e.g., between the frontal lobe and sensory areas) and greater connectivity within regions (the Underconnectivity Hypothesis). Additionally, individuals with ASD show greater activation of low-level perceptual areas (e.g., posterior occipital areas that represent smaller areas of space with less feature integration) and less activation of higher level areas (such as the fusiform face area). The possibility that less top-down frontal influence on perceptual areas may be associated with

savant properties was tested in several intriguing studies using repetitive Transcranial Magnetic Stimulation (rTMS) to suppress frontal activation in non-ASD individuals. Some, but not all, participants in these studies showed enhancements in a variety of skills: drawing with more detail, noticing errors while proofreading, subitizing objects, and having more veridical and fewer false memories.

The relative emphasis on local versus global information, regardless of the neural explanation, is associated with the fact that individuals with ASD may create more precise, veridical representations of one or more perceptual systems (e.g., auditory pitch, visual scenes). Perceptual abilities in turn may serve as the basis of savant strengths. All musical savants have perfect pitch, for example (and non-savant individuals with ASD have better pitch perception and memory than non-ASD individuals).

Individuals with ASD may either have innate lower-level perceptual processing capabilities or may develop these capabilities due to greater attention to certain stimuli. The fact that development and experience may play a role is supported by the fact that people with ASD also show more sensitivity and responsiveness to perceptual stimuli. It should be noted that enhancement of lower-level perceptual processing is associated with related strength in memory for lower-level perceptual information. Nonetheless, the general argument is that quality of perceptual inputs, attention/sensitivity to perceptual information, and high quality veridical memory representations could, together, serve as the basis of savant strengths. Indeed, the characteristics of many savant creative achievements such as the achievements of Wiltshire and Paravicini involve creating striking veridical reproductions of visual or auditory information.

The direct veridical replication of information without creative generation does not seem to be the limit of savant abilities, however. Darold Treffert followed some musical and artistic savants for thirty plus years. He found their initial skills were based on the ability to veridically reproduce music or visual scenes. Over the years, their skills seemed to evolve to be more productive. Leslie Lemke, a musical savant, for example, was initially able to copy full concertos after hearing them only a single time. Later, Lemke began to improvise and play variations of pieces he had heard and then began to compose his own music. Likewise, Stephen Wiltshire can copy scenes exactly as he sees them, yet is also able to create his own original drawings.

While there is considerable support for the idea that perceptual representations are related to savant skills, other characteristics of individuals with ASD may also play a role in talent development. For example, single-mindedness and differences in social functioning may be associated with ASD individuals' motivation to practice. Interest in sorting and taxonomizing various objects may also contribute to savant skills. Wiltshire, for example, shows keen interest in the details of architecture and automobiles. Another artistic savant, Gregory Blackstock, has achieved fame for his elaborate visual taxonomies of animal species, automobiles, and other object categories. Keen interest in the features of objects in the world may help guide savant talent development.

Summary of Creativity in ASD

In summary, individuals with ASD have perceptual and cognitive styles that lead to limitations on some aspects of creativity, such as fluency in divergent thinking. At the same time, these factors are associated with talent in creative domains such as visual arts and music. And, a small number of individuals with ASD show prodigious talent that leads to international renown.

Conclusion: Creativity in ADHD & ASD

In conclusion, there is evidence that both ADHD and ASD individuals have some enhanced skills in creative domains; however, the nature of these differences and their underlying bases are thought to be different.

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Advertising

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Many a small thing has been made large by the right kind of advertising

Mark Twain

In every advertising agency is a suite of offices within which people work mainly with “creative” ideas. They have titles such as “Account Planner/Researcher”, “Copywriter/Art Director”, “Community Manager”, “Creative Director”, “Digital Creative Director”, “Digital Copywriter/Art director” or “Designer/Specialist” to name but a few. Yet not everything they produce can be termed “Creative”. Some of it is. Much of it is not. Who can say? Someone might look at an advertisement and say, “wow this is creative!” Yet another person looks at exactly the same piece of work and says: “this isn’t creative at all. How can you say that it is?” The reality is that the extent to which an advertisement, whatever the medium, is creative or not remains a matter of judgment. Some argue that as long as the advertisement “works”, in terms of meeting the objectives of whoever initiated the communication, then why worry? Well perhaps if more people thought it was creative then the advertisement might work even better, grabbing the attention of more people, being more persuasive and thereby effective. This entry investigates what Advertising Creativity is, what makes it effective, how it is developed, and what expertise, processes and structures are important in this development?

Defining Advertising Creativity?

What would make you view an advertisement as creative? One thing would be if it surprised you. You might think, “That’s a strange TV commercial for pizza. I haven’t seen anything like that before. I wonder why they did that and what is it about?” Or you might see a viral post for a car that didn’t look like a normal car advertisement. “What on earth is that about you might wonder” What creativity does is challenge your ideas of the norms. It surprises you and makes you wonder what the communication is about. It might amuse you, make you laugh, challenge your ideas on something, or make you think about a product in a new way. It’s what you might consider an original idea. However, there is a twist. That creative advertisement operated within a confined space. Yes, it was creative, but it was a restricted form. In essence the creative idea was tied to a strategic objective. That objective might be to communicate the quality of the ingredients of the pizza, or the safety features of the car. The creativity was not random: it had a purpose.

To look at this more closely, most current definitions of advertising contain two core elements. Firstly, advertising involves a paid form of message that is largely controlled by an identified sponsor. Second, the aim of this message is to inform and persuade consumers, influencing how they think or act toward the organization’s ideas, products and/or services. Likewise definitions of what constitutes a creative idea usually contain two key elements. Creative ideas must be original, novel or different from what has been done in the past. In addition, creative ideas are relevant, meaningful or appropriate to the situation (Guilford, 1968; Runco and Charles, 1992). Combining the two terms provides a definition of creative advertising:

Creative advertising involves original messages that are meaningful to the target market and inform and persuade consumers about the sponsor organization’s ideas, products and/or services.

This definition acknowledges that it is the perception of the target audience that essentially determines both the advertising idea’s originality and appropriateness. However, as noted above, advertising must meet a commercial imperative: brand objectives must be met, and these objectives are set by the sponsor organization and are based upon their current market situation.

In this respect the appropriateness of the advertisement is determined by its ability to achieve the sponsor's objectives by communicating the brand message in a way that is meaningful to the target audience. So is creative advertising effective? The answer lies in whether a highly original and appropriate advertising idea is able to meet those brand objectives, given the advertising environment they face?

The Advertising Environment

Advertisers face an increasingly complex and complicated environment. That environment is now very different from the golden years of advertising in the 1950s and 1960s, when TV was an exciting new medium, entertainment and media options were limited, consumers were looking for new products to enhance their lives, and subsequently the motivation to process advertisements was high. As the consumer society developed, consumers became more discerning and knowledgeable, and increasingly have seen advertising, whatever the medium or format, as intrusive. Today advertisers face a multimedia environment that is highly cluttered and where most consumers have low motivation to process advertisements. Added to this is an abundance of content and entertainment options that are available to consumers at their fingertips, a general distrust of advertising, and easily accessible social sources of information. In this competitive environment, highly original and appropriate advertising offers a way to cut through the clutter and be seen and/or heard.

Ideas that are original, novel and unexpected to the target audience draw their attention and demand processing capacity (Till and Baack, 2005). However, while attention grabbing advertisements are important, this is not enough. Creative advertisements cannot be just art for art's sake, the commercial imperative of advertising means that they must communicate a brand message in a way that is meaningful and persuasive. Hence, both elements assist in determining the effectiveness of creative advertisements. Originality to grab the attention of the audience, and also appropriateness, or presentation of the core brand message in a manner that that target audience will be responsive to (Ang et al., 2014).

Nevertheless, this is not to abandon the importance of art to the process of advertising creativity. *Artistry* in advertising builds upon the core creative idea, and involves the final aesthetic qualities resulting from the executional elements that occur as part of final advertisement production. Artistic advertisements are visually attractive, flow well, and are easy on the eye. Both the difficulties in evaluating highly creative ideas, and the highly constrained environment in which advertising occurs, increase the importance of well-presented, artistic work.

The evaluation of creative ideas is a highly problematic process. Research illustrates that while evaluations of an idea's originality are relatively consistent, judgments of appropriateness are much less so, even among groups of people with similar backgrounds (West et al., 2008). Given that creative ideas involve highly unusual or novel ideas, it is difficult to get others to see how those unusual ideas make sense. In addition, high media costs mean most advertisements must get their message across in a very short period of time. Under such circumstances presentation elements matter (Csikszentmihalyi, 1999), and the need for artistry involves more than just aesthetic quality, but also ensuring that elements within the advertisement are coherent in order to reduce audience processing requirements.

In summary, creative advertising works as the originality component grabs the attention of the consumer, increasing the processing capacity they put toward the advertisement and increasing the likelihood that they take in the core brand message. Additionally, if the advertising idea is visually attractive and coherent, consumers will be more willing to attend to the advertisement and it will be easier for them to process the message. Given environment constraints these elements are particularly crucial in advertising as unlike other fields, such as for new products or the fine arts, consumers generally put very little time or effort into processing advertisements. It is therefore of little surprise that the development of highly creative advertisements is a core focus of the advertising industry.

The Creative Continuum

However, not all creative ideas are created equal. Both originality and appropriateness should be viewed as a continuum, not an absolute. While both are required for an idea to be creative, it is not easy to determine the degree to which each is needed to meet organizational objectives. In addition, increasingly advertising creativity researchers' view that these elements cannot work independently, but that effective creative advertising ideas will present appropriate brand messages in a novel way. In other words effective creative does not first grab your attention by presenting something novel, and then proceed to present the organization's core brand message, instead the novel connection is part of the brand message. The combination of originality and appropriateness presented in a coherent aesthetically pleasing way is crucial in an advertising setting, where media and environmental constraints mean advertising ideas must be transmitted in very short time periods to consumers with low motivation to process.

Hence creative advertising works to grab the attention and processing capacity of the target audience, and within that novel message, convey a brand message. Of course an alternative to achieving the same objective is to increase the frequency to exposure of less creative advertisements, but this can be very expensive. Moreover, having high repetition of uncreative advertisements can quickly lead to advertisement "wear-out" (Lehnert et al., 2013). Wear out is the situation where the effectiveness of repetitive advertisements diminishes with exposure, and may even result in negative perceptions of the advertised brand.

The Organization's Brand Objectives

What is required for a creative advertisement to be effective is dependent upon what the organization is trying to achieve. Promotional objectives range from attaining initial awareness of a new idea, to changing the perceptions consumers have toward the brand, through to final product purchase. These promotional objectives will in turn depend upon the current state of the organization's brand market position as well as product category and consumer characteristics. For example, for product categories where consumers perceive high purchase risks, such as high price or social esteem type products, less original but more appropriate advertisements may be the focus, as consumers are already highly motivated to process advertisements. In addition, the promotional objectives for existing well established brands may be more focused on appropriateness relative to originality, as the aim is on reinforcing the primary brand message to existing customers. In contrast, attention grabbing originality will be a greater focus for new brands who have to gain initial awareness of their new product and break through the clutter.

However, despite varying requirements for the two core creative components, there is little argument about the significant impact highly creative advertisements can achieve. Therefore the question becomes - why settle for a one or other of the two components? Why not just develop advertisements that are high in originality and appropriate to start with? The answer lies in the difficulties in developing highly creative advertising.

Developing Creative Advertisements

While it has long been acknowledged that highly creative advertisements can have dramatic effects, understanding how to produce them has proven more problematic. The development of creative advertisements include an array of general processes that are not unique to advertising. These general processes involve (i) problem definition, (ii) idea generation and refinement, and (iii) presentation and evaluation, albeit in an iterative and integrated fashion. However, despite the universality of these creative development processes, the advertising industry provides some unique contextual factors that influence each stage. Central to these contextual factors is the advertising agency.

Traditionally the development of large scale advertising campaigns has primarily been outsourced to advertising agencies. These advertising agencies must be equipped to develop the type of creative advertisements required by clients. This requires processes and structures that enable an understanding and management of each client's unique objectives, as well as systems to ensure effective development and evaluation of creative ideas at different stages of completion (Kover, 1970). Subsequently, agencies provide specialist creative expertise used in the generation, evaluation and production of creative advertisements, as well as the effective use of media. Central to these specialists is often a creative dyad, a copywriter and art director who work together to generate, refine, and bring to life creative advertising ideas—the "creatives."

Creative Problem Definition

Even before the creatives begin the process of generating early stage creative ideas, those processes will be influenced by how the advertising objectives have been defined. How a problem is defined influences how people go about generating a solution. In the advertising industry the sponsor, or client, will set the advertising objectives and provide information to guide the creative idea. In agencies this will often take the form of a briefing document. This document usually contains client objectives and operational requirements, brand values, and a varying degree of consumer information. This document provides cues that can prime information used in creative ideation processes, as well as acting as a basis for idea evaluation. As much of this priming information is focused on brand objectives, it is likely to increase the appropriateness of the creative ideas generated by the creatives, but can potentially limit their originality.

However, it has been identified that the extent to which problem definition information limits a person's ability to generate original solutions is dependent upon what type of solution they are trying to generate, as well as the inherent associative abilities and learnt knowledge and expertise of the people generating the creative idea. Agency creatives tend to focus on generating original solutions (Csikszentmihalyi, 1999), so if they believe through their interaction with the client, as well as their view of the creative brief, that they are able to generate more novel ideas, they are likely to do so.

In addition, while for most people extensive informational cues may result in them becoming fixated, resulting in more appropriate, but less original solutions, the strong associative abilities and expertise of creative individuals allows them to go beyond the use of these cue in their creative idea generation processes. That is not to say that a preponderance of appropriateness focused problem definition primes will have no influence on agency creative personnel. Indeed, agencies are often structured in a way that shields the creatives from too much information, at least during early stage creative ideation processes. However, the effect on the creative dyad of highly detailed appropriateness cues may be primarily due to it being seen as a signal that the client is not willing to explore more risky novel alternatives.

If creative personnel know that the client is not going to accept more novel solutions they are likely to focus on just giving the client what they want (West et al., 2008). Indeed client willingness to explore has been consistently shown to be one of the most significant influences on the type of creative advertising ideas that are generated (Koslow et al., 2006). Moreover, if the client views the agency as a vendor versus a partner, this will have a significant impact on the creativity of the advertising the agency produces.

The quality of the advertising creative is therefore dependent upon not just the idea generator's creative abilities, but the views, and relationships that are developed with those evaluating their ideas.

Creative Idea Generation and Initial Refinement

While problem definition information provides information used in idea generation processes, it is individuals who generate new creative insights. Developing creative ideas involves combination processes (Guilford, 1968; Mumford et al., 1991). Ideas that involve the combination of highly unusual domains, or areas of thought, will result in highly original combinations. However, these unusual combinations must also be seen as appropriate to those evaluating the idea. Hence advertising idea generation can be seen as involving what are referred to as divergent thinking and convergent thinking processes (Guilford, 1968) (See Divergent Thinking).

Divergent thinking involves creative leaps of insight, making connections between distant domains of thought. Convergent thinking involves connection of ideas that are more closely related (Guilford, 1968). This convergent thinking process can be used to refine early stage divergent ideas. This refinement process involves taking highly unusual or divergent connections, and undertaking further research and/or contemplative processes in order to strengthen the links between these divergent ideas. These two types of thinking can be thought of as a continuum. Within the total body of human knowledge all ideas are related if one follows a chain of connection far enough, but some concepts are more closely related than others.

The need to have expertise, and the fact that each individual's knowledge capacity is limited, means that most people specialize in certain knowledge domains. This means that external people, specialized in their own particular area of expertise, who are viewing another person's original idea, will view any connections between distant knowledge as original. However, those external observers will find it difficult to see how those ideas are connected, or make sense, as they are unlikely to possess the knowledge of the two divergent domains being connected. Developing highly original ideas that provide a novel depiction of the brand message in a manner that the target audience will see as meaningful is therefore a difficult process, requiring rare expertise.

Given that creative thinking processes involve both an ability to make unusual connections between distant domains, but also refinement of those ideas into a form that others will understand, two core types of expertise are central for advertising creatives. First is the idea generator's associative abilities. Creative individuals appear to have the ability to connect a broader range of more distant ideas than others, in what is referred to by Mednick (1962) as possessing a flatter associative hierarchy. Of course connecting distant domains of knowledge requires an individual to have knowledge of those distant domains to make those associations. Hence one would expect creative individuals to be generalists who also possess high degrees of knowledge in multiple domains, and/or a strong ability to attain such information as required. It is of course very difficult to be a generalist expert and there is an additional problem with high levels of expertise - mental set fixation (See Remote Associates).

Mental set fixation is the problem where experts have difficulties developing original connections as they become fixated on a particular domain due to their existing knowledge. One way creative personal in advertising agencies overcome this problem is by using divergent thinking techniques. These techniques are variants of the creative thinking techniques developed in multiple fields, such as the use of metaphor and analogy (Madrigal and King, 2017). These techniques are essentially associative techniques. Associative techniques force the idea generator to bring in divergent domains, or unusual ideas, to use in their connection processes. For example, the advertising creative might use a random word from a dictionary as the basis for generating new associations in relation to the core brand message. These individuals' very flat associative hierarchies means they can apply techniques that force connections between very unusual or distant domains. Such techniques would require too great a leap for most people (See Analogies).

Making distant leaps is part of the creative development process, but those leaps must also result in ideas that communicate the brand message. Advertising researchers have looked at award winning creative advertising and identified techniques that emulate what advertising creative personnel do when generating highly original and appropriate combinations. The two best known of these are the Templates Technique (Goldenberg et al., 1999) and the Remote Conveyor Model (Rossiter, 1994). Both of these approaches illustrate how great advertising creatives work to provide an unusual connection that also conveys the core brand message. The use of these techniques has been shown to improve advertising creativity, at least on student samples (Scott et al., 2004). This research points to the importance of the use of such techniques to overcome mental set fixation and help to ensure advertising that meets both the originality and appropriateness criteria. These findings are significant as it points to the fact that while the quality of creative ideas is dependent upon a degree of individual associative ability, an individual's creativity can be improved by increasing their knowledge and/or exposure to alternative domains, in conjunction with training in associative techniques.

Team Creative Processes: Expertise and Refinement

The advertising creative dyad provides additional lessons in relation to creative idea generation and refinement processes. While it is an individual who makes connections between unusual domains, he or she will be influenced in their combination process by information from their external environment. One advantage of the creative dyad is that the second creative person provides a source of additional external information. Given that in the advertising setting that other person also has strong domain knowledge and

associative abilities, the quality of this information in assisting divergent thinking processes is likely to be high. In addition, this second person not only provides a basis for divergent information primes, but also assists with initial idea evaluation and refinement processes (See Teams).

Given that it is difficult for external judges to evaluate ideas that are highly divergent connections as also appropriate, the expression of creative ideas is a risky process. Creatives acknowledge that they face constant evaluative pressure and one means to alleviate some of that pressure is having a like-minded person with which to share early stage creative ideas. During the initial creative idea generation process, the creative dyad will normally generate a number of potential advertising ideas, but present a smaller number for external evaluation outside their team. The use of a dyad allows that larger group of divergent ideas to be expressed, and refinement processes to occur, in an exchange process with a person who understands the difficulties in creative evaluation and whose strong associative abilities also mean they are likely to appreciate unusual divergent connections. This small group expression and refinement process will assist in developing stronger connections between the divergent ideas, providing arguments and refinement of those early stage ideas.

Idea Expression and Refinement

Having highly creative people generate creative advertising ideas is only one small part of the process in developing creative advertisements. Between the initial idea generation stage and final production is often a long and expensive series of interrelated and iterative steps. These steps are made complex by the difficulties in evaluating highly creative ideas and the range of stakeholders, who often have differing views on what constitutes good creative advertising. In the agency setting the primary conflict in these views is often between the creative idea generator and the final client. However, agencies have developed extensive systems and structures to assist in overcoming these conflicts and increasing the chances of developing great creative ideas, as well as having those ideas accepted (Kover, 1970).

While the creatives are largely focused on creative idea generation processes, other agency personnel will influence this process by providing information and evaluative cues. In advertising agencies, account personnel, made up of account services and account planners are often used to manage the relationship with the client as well as providing information on the market and consumers. These groups were referred to by Kover (1970) as being part of the client-centered system. Both of these groups provide valuable evaluative information, based upon both an understanding of the client and the market. An additional benefit of the use of account personnel is that it keeps a distance between the creatives and a preponderance of appropriateness criteria which may stifle their creativity. Agency production staff also influence creative idea generation processes. The media by which the advertisement makes its way to the final consumer influences the message. Given the recent rapid and ongoing changes in media, input from specialist production people with new media expertise are often provided early in the creative development process to ensure the creatives know what is feasible.

In the process of advertising development, external evaluation processes do not stop with the creative dyad and the inputs from the account and the production teams. Indeed, given the high production and media costs associated with major brand campaigns, creative advertising ideas will usually go through a series of extensive evaluation and refinement stages. In the context of the agency process the ideas the creatives select and refine will subsequently be evaluated by a creative director. The creative director is a senior creative with a boundary spanning role. They understand both the creative idea development process, but also the perspective of the client. The creative director must therefore gauge the degree of client risk tolerance, and where appropriate, work to present and persuade clients, championing the value of creative options.

After the creative director has screened and provided feedback on the creative ideas, further evaluation processes will occur involving the client and often formal testing methods. Formal testing methods provide an evaluative mechanism often in the form of copy testing but increasingly using online experimental methods (i.e. A/B testing) that can simultaneously show different versions of an advertisement to a large representative group of customers to see which version is more effective. Research suggests that formal testing may actually result in more creative advertisements, as if creatives know the testing criteria they can develop highly creative ads and then fit elements into the advertisement to meet those criteria (O'Connor et al., 2016). Hence they are not an input into ideation process, but an output criteria used in assessment of ideas. These formal tests can assist in ensuring client objectives are met, helping to sell the final creative advertising idea. Selling of creative ideas to the final client (or if the idea is developed in house to senior management) is a major focus, as ultimately it is the client who pays the bill and decides upon the final creative advertising idea to be launched.

Summary

While this entry is only able to present a brief discussion of the issues and findings evident from the literature, it is clear that there is much to be gained from research into advertising creativity. The industry provides a unique setting requiring highly creative ideas to be developed under constrained circumstance in a complex environment. This has led to the development of specialized organizations with highly refined processes. These processes assist in maximizing both the likelihood that creative ideas are initially generated, but equally important that they make it through a long and difficult process of evaluation and refinement. The industry, the ideas, the people, the processes and structures, provide a crucial area of research for developing understanding of creativity.

The Future of Advertising Creativity

As the environment changes so to do the elements within those advertisements that drive their effectiveness, and subsequently the processes required to develop them. While there is insufficient room in this chapter to discuss even a small fraction of the issues, there is one core issue that demands mention. This is the growth in new digital media. This rapid change, particularly the growth in social media, is changing consumer behaviors, reducing the prevalence of traditional media use, decreasing consumers' tolerance for advertising messages even further, and leading to organizations searching for new ways to engage with consumers.

This changing media landscape has major repercussions for how and where creative advertising campaigns are developed. In a digital social media world, the ability and propensity to develop advertisements by an organizations for the use on its own media platforms, such as webpages and social media sites, has increased dramatically. At the same time the development of high quality promotional materials has become much easier. These changes have led to a growth in organizations generating their own creative advertising content, and a reemphasis on Content Marketing. Content Marketing, involves the generation and dissemination of information that the target audience finds valuable but is not primarily focused on selling a product or service.

However, while it may be relatively easy for companies to develop high quality video and audio content, the advertising ideas themselves must still be creative. In relation to developing such creative content, it is clear that this is not a simple process. Developing great creative advertising requires a magical combination of rare associative talent and the correct environment, structures, and evaluation processes that encourage it to occur. So while the advertising environment has changed, creativity, and the ability to develop it, still rules.

Acknowledgment

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Aesthetics

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Introduction

Aesthetics refers to the experience of features of our world, such as landscapes, flora and fauna, and human faces and bodies as well as human-made objects, such as artworks, music, literature, film, performance, architecture, and design products. This latter category of human-made objects has been the most studied area in the history of the psychology of aesthetics, which is the study of the psychological mechanisms and processes that underlie aesthetic experiences. This entry will briefly describe the history of the psychology of aesthetics, present the various definitions and conceptualizations of the aesthetic experience, and most pertinent to this volume, discuss the relationship between aesthetics and creativity.

The formal study of aesthetic experiences can be traced back to the work of philosophers, such as Gottfried Wilhelm Leibniz, Immanuel Kant, and Alexander Gottlieb Baumgarten. It was Baumgarten, in the early 1700s, who coined the term *aesthetics*. These scholars used introspective, conceptual, and anecdotal methods to examine and describe the aesthetic experience. In the late 1800s, psychological aesthetics branched off from philosophical aesthetics following the first formal scientific studies of the aesthetic experience, which were conducted by Gustav Theodor Fechner, a psychophysicist who studied the relationship between the physical properties of objects and people's psychological experiences of such properties.

In some of his earlier works, [Fechner \(1876\)](#) examined people's preferences for the golden section, a mathematical ratio of 1 to 1.618. Fechner's work on the golden section involved presenting to research participants a set of stimuli, such as rectangles, that varied to the extent to which they possessed the golden section property. The participants were tasked with choosing which stimuli they preferred. Fechner found that people preferred basic shapes that had the golden section property over those that did not have the property. The preference for the golden section is still widely debated today as findings since Fechner have been mixed.

As a field of study, the psychology of aesthetics after Fechner experienced consistent growth in the number of researchers entering the field, important discoveries, new methods and technologies developed for examining aesthetic experiences, academic journals, conferences, and laboratories specific to the topic (see *Relevant Websites* and *Further Reading*, below). The field of creativity experienced a similar trajectory and growth. Interestingly, aesthetics and creativity have largely been separate fields with aesthetics scholars doing mostly aesthetics research and creativity scholars doing mostly creativity research. This disconnection between the two fields becomes questionable when creativity and aesthetics are considered in practice because what people create are often later experienced aesthetically by others: artworks have their viewers, music has its listeners, architecture has its inhabitants, literature has its readers, and design objects have their users. Creativity and aesthetics represent the two endpoints of the making and experiencing continuum. One is the beginning and the other the end.

What Is an Aesthetic Experience?

Historically, scientific research on aesthetics focused on people's primarily positive responses to stimuli such as artworks, musical pieces, and design objects. The most commonly examined responses are preferences, liking, appreciation, and pleasure. This focus on positive responses may not simply be the result of the bias of researchers towards such responses, but instead may have its roots in people's common interpretation of what aesthetics means. [Jacobsen et al. \(2004\)](#) demonstrated this in a study in which they asked participants to generate words that they felt are associated with aesthetics. "Beauty" was the most common word association having been named by 91.6% of participants. Importantly, participants identified 38 different adjectives as being associated with aesthetics, and of these, 26 had positive valence. Only four words, such as "ugly" and "repulsive," were negative in valence. These

results support the idea that people see aesthetics in a positive light and may underlie the high prevalence of aesthetics research that have focused on positive responses.

Based on these and similar findings and the emphasis on positive aesthetic responses throughout the history of research on aesthetics, it is clear that aesthetics has a more positive than a negative connotation. However, what cannot be ignored is the fact that aesthetic responses are highly variable and span the entire range of negative to positive responses. Even in studies that use preference or liking or pleasantness measures, they are presented along a continuum, typically using a Likert-type or semantic differential scale in which the corresponding opposite negative responses are provided. Thus, liking is paired with disliking and pleasantness is paired with unpleasantness. More generally, positive is paired with negative.

Emotions is another category of responses that arises during aesthetic experiences. Silvia (2009) identified three types of emotions beyond the typical positive responses: knowledge emotions, hostile emotions, and self-conscious emotions. Knowledge emotions are related to the ability to understand what one is looking at. Examples of knowledge emotions are confusion and surprise both of which may be experienced when an artwork that one is looking at is overly complex and unfamiliar, and especially in the case of surprise, there are also aspects of the artwork that are unexpected. Hostile emotions such as anger and disgust may arise if the art that one is engaging with conflicts with one's belief system and goals. Hostile emotions could thus be a response to artworks that are considered offensive, insensitive, or repulsive, such as a painting depicting the horrors of war or conceptual art that purposefully defames or pokes fun at religious icons. Finally, self-conscious emotions, such as pride, guilt, and embarrassment, are related to secondary emotions, which arise during early childhood primarily because they require experience with social interactions and internalization of standards set forth by adults and society. For instance, a museum visitor looking at a sexually graphic photograph could feel embarrassed because he or she might have been taught, since a young child, that graphic nudity is inappropriate and even immoral. In this case, the content of the artwork being viewed clashes with internalized standards for appropriateness and morality.

Aesthetic experiences therefore include the gamut of responses including preference and liking and joy and satisfaction as well as anger, sadness, and anxiety. In addition, there are also very specific cognitive processes involved in aesthetic experiences. These include basic perception, or noticing and directing attention to specific elements of a stimulus, such as the shapes, objects, lines, and colors of an artwork; spatial reasoning, or making sense of the compositional structure of an artwork; imagination, or visualizing what the people depicted in an artwork might be doing as well as what might have happened before and after the depicted scene; and problem solving, or determining what artistic style a particular artwork belongs to as well as trying to comprehend what message an artist is trying to convey in an artwork. A noteworthy fact regarding aesthetic experiences of art is that the above responses occur in a very brief amount of time. Studies of people looking at artworks in museums showed that, on average, people spent approximately 30 seconds engaging with artworks that are considered masterpieces of the museums' collections. Remarkably, this duration included the amount of time spent reading the labels that accompanied the artworks (Smith and Smith, 2001). Thus, one of the distinct features of aesthetic experiences of art is the amount, complexity, and richness of responses—perceptual, cognitive, emotional, and evaluative, among others—that manifest in a relatively short amount of time.

The Aesthetics Triumvirate

The aesthetic response results from the converging effects of three components—the *aesthetics triumvirate*—that are involved in all aesthetic experiences: the object, the perceiver, and the context in which the experience is taking place. Variations within each of these components and their interactions will ultimately determine the outcome of the experience. The science of aesthetics has led to some important findings that allow predictions and explanations of some aspects of aesthetic experiences.

The Object

Visual art is the most studied category of aesthetic objects. Visual artworks have certain characteristics, both physical and conceptual, that influence how they are perceived and aesthetically experienced. One of the most basic characteristics of visual artworks is their level of abstraction, which could range from representational to purely abstract. Representational works depict people, objects, and environments such as buildings and landscapes. Examples of representational works include Leonardo da Vinci's *Mona Lisa*, Vincent van Gogh's and Rembrandt van Rijn's self-portraits, and Peter Paul Rubens' depictions of religious and mythological subjects. In contrast, purely abstract works have no recognizable objects or figures and instead may be comprised of splotches of color, basic shapes, and lines. Examples of abstract works include Jackson Pollock's drip paintings and Kazimir Malevich's black square, which as the title suggests, is a canvas painted in pure black.

In general, people show a preference for representational artworks over abstract artworks. This effect appears to be related to the ease of which people are able to make meaning of representational artworks (Millis, 2001), a process that is initiated by the simple recognition of what is depicted in the work, which then allows one to interpret and understand what one sees and perhaps to relate personally to the work. In contrast, abstract artworks not only have little to no recognizable objects, but they often also require the viewer to determine and interpret the concepts and ideas behind the works, which require background information that some art viewers might not have. This lack of information makes the search for meaning difficult, if not impossible, leaving the viewer unable to cognitively engage with the artworks.

In addition to level of abstraction, there are also visual and structural characteristics of artworks that influence the manner in which they are perceived and aesthetically experienced. Artists devote considerable energy to composing the various elements of their creations so that the visual impact and expressive quality of their artworks are maximized. One important aspect of composition is visual balance. For a painting, balance is achieved when the individual elements of the painting are balanced around the center of the canvas. It is important to note that the “center” does not have to be the geometric center of the pictorial frame, but instead could be at any location in which the weights of individual elements are balanced ([Arnheim, 1982](#)). For example, the weight of a large, visually “heavy” object near the edge of a painting may be counteracted by several smaller objects on the other side of the painting.

Artists go to great lengths to create works that are optimally balanced. An artist known for his systematic and rigorous compositions is the Dutch artist Piet Mondrian, who is famous for his abstract paintings from the 1920s and 1930s that were made up of black horizontal and vertical lines and colored squares and rectangles (primarily in blue, red, and yellow), of various sizes and that were carefully arranged on a white background. Mondrian spent a great deal of time and energy working and reworking his paintings so that each would have the best possible composition. A question that arises is whether viewers of artworks, such as those by Mondrian, are actually able to determine whether one artwork has better compositional balance than another. [McManus et al. \(1993\)](#) addressed this question in a study that asked participants for their preference for one of two versions of a pair of Mondrian paintings. One version consisted of an image of an original Mondrian painting while the other version consisted of the same image that had some of its elements modified so that its composition was perturbed. The results of the study showed that participants preferred the original over the perturbed versions significantly above chance level, which is evidence that people are able to perceive differences in, and variations in the quality of, the compositions of artworks. According to [Locher \(2003\)](#), “the structural skeleton or network created by a skilled artist is the correct or best organization of its pictorial features ... Such an organization should be, according to this view, highly salient to an observer regardless of his or her level of sophistication in the visual arts” (p. 159). Locher’s *visual rightness theory* provides evidence for the relationship between creativity and aesthetics such that what the artist wishes to express in a work is able to be aesthetically experienced by the person viewing the work.

The Person

The second component of the aesthetics triumvirate is the viewer, who stands at the receptive end of the process that began with the artist creating an artwork. There are certain characteristics of the viewer that could impact how the aesthetic encounter transpires. The most researched of these characteristics is arguably the amount of knowledge the viewer has about art. Such knowledge could come from formal education in art, such as taking art studio, art history, or art theory classes, or informal experiences with art, such as having art as a hobby, regularly visiting art galleries and museums, and attending art shows, performances, and similar events. Research showed specific differences in aesthetic experiences between people who were knowledgeable and less knowledgeable about art. For example, art novices are more likely to think about artworks in terms of the content that they depict and how the artwork might relate to them personally ([Hekkert and van Wieringen, 1996](#)). In contrast, art experts think about artworks in terms of the art style that they belong to (e.g., Renaissance, Abstract Expressionist, and Impressionist) as well as their formal characteristics, such as their compositional structure ([Cupchik and Gebots, 1988](#)).

Differences between these two groups are also reflected in how they engage with representational and abstract art. Because of their ability to process art in terms of style and formal elements, art experts are more interested and are better able to appreciate even the most abstract and conceptual artworks. Art novices, however, have difficulty engaging with, and show little appreciation for, such works unless they are provided with information that could help them to interpret the works. For instance, an art novice looking at abstract paintings by Willem de Kooning might not know how to interpret the work. The late career paintings that De Kooning made consisted of thick, curving, ribbon-like lines that flowed across swaths of color with no discernible objects on the canvases. This viewer could benefit from some information about the paintings and about the artist. de Kooning made the paintings near the end of his life when he was struggling with serious health issues and they were a significant departure from his earlier works, which were harsher in character and which often included figurative elements. This additional information gives the artwork more meaning.

The Context

The specific characteristics of the viewer and of the artwork determine, to a large degree, how the interaction between the two will transpire and what will be the outcome of the aesthetic experience. The third component of the aesthetics triumvirate is the context in which the aesthetic experience takes place, or in other words, where the interaction between the viewer and the artwork occurs. Although context is as influential for the aesthetic experience as the two other components, it is the one that is least understood. This state-of-affairs stems from the lack of research on the effects of context, which in turn is likely due to the methodological difficulties associated with isolating the effects of context on the aesthetic experience. However, in the past decade or so, we have learned a great deal about the specific effects of context.

For instance, specific features of the physical space in which an artwork is presented affect how that artwork will be experienced. The traditional context for art is undoubtedly the art gallery or museum. However, in recent years, the massive expansion of digital media use, especially for presenting and viewing art, has led to questions such as what are the advantages of viewing a genuine artwork in a museum versus a printed reproduction or digital version of the same work presented on a computer screen or through

some other format? Studies have shown that aesthetic experiences with genuine artwork presented in the museum are generally more intense than aesthetic experiences with the same artwork presented in a different format. Viewers also find artworks presented in a museum to be more likeable and interesting than the same artworks presented in a laboratory (Brieber et al., 2014).

The context therefore serves as the basis for the interaction between the artwork and the viewer, and it is this interaction that represents the relationship between creativity and aesthetics. In this sense, the creative work of the artist is encapsulated in the artwork, and the person engaging with this work will examine, attempt to make meaning of, and evaluate the work. The next section formally describes the relationship between creativity and aesthetics.

Models of the Aesthetic Experience: From Creativity to Aesthetics

The two earliest and currently most highly cited models of aesthetic experiences were proposed by Chatterjee (2004) and Leder et al. (2004). Both models describe the main processes that take place during aesthetic experiences in terms of three broad information processing stages. In the first stage, the viewer automatically processes the basic visual features of an artwork, such as its complexity, symmetry, contour, and color. During the second stage, the viewer uses his or her memory to identify and think about what is depicted in the artwork and the art style to which the artwork belongs. Finally, in the third stage, the viewer attempts to derive meaning from the work and determine the concepts and ideas underlying its creation. It is also at this final stage where judgments about the artwork are made.

In his Mirror Model of Art, (Tinio, 2013) argued that these three broad stages of the aesthetic experience of art correspond directly to the three stages of art making, although in a mirror-reversed fashion. Specifically, art making begins with a concept or idea that the artist initially expresses—using painting as an example—as a rough sketch on paper or underdrawing on canvas. Subsequently, the artist develops on this initial layer by elaborating on the drawing or by adding more materials, such as paint, on the canvas. It is at this second stage that the content of the work such as objects and forms become visually distinct. Lastly, the artist finalizes the work by further refining the content and adding color and other finishing touches. According to the Mirror Model, this last stage of the creative art making process is where the aesthetic experience begins with the viewer quickly and automatically processing the surface-level features of the artwork. The viewer then engages with the content of the work, identifying objects that might be recognizable and categorizing the artwork in terms of its style. Finally, the viewer attempts to make meaning out of the work and tries to understand the ideas and concepts underlying its creation as well as what the artist might have been trying to express. Therefore, the three stages of the aesthetic experience correspond, in reverse order, to the three stages of the creative art making process.

The Mirror Model of Art describes the interface between art making and art viewing. This formal description represents aesthetic experiences in general in that creative products have their audience: paintings and sculptures are viewed and evaluated; poems and stories are read and contemplated; architecture and design products are used and appreciated; and music is listened to and enjoyed. In these examples, creativity and aesthetics are closely intertwined. It is therefore curious that creativity and aesthetics, as scientific fields, have remained largely separate with scholars from each side rarely integrating with the other. Creativity and aesthetics scholars have started to address this state of affairs (Vartanian, 2014). Both fields can only benefit from the work that they do to integrate the two sides.

Conclusion

Over a century's worth of scholarship on the psychology of aesthetics has revealed the complex nature of the aesthetic experience. The aesthetic experience involves cognitive responses such as perception, memory-related processes and meaning-making; a wide range of emotions, both typical such as pleasure and displeasure and liking and disliking, and atypical, such as repulsion, disgust, and shame. The above responses are a product of an interaction amongst the aesthetic object, the perceiver, and the context in which the aesthetic experience takes place. Finally, creativity and aesthetics are related in such a way that stages of the aesthetic experience correspond to stages of the creative process.

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Relevant Websites

- APA Division 10 (<https://www.apa.org/about/division/div10>).
- Society for the Psychology of Aesthetics, Creativity, and the Arts (<http://www.div10.org>).
- International Association of Empirical Aesthetics (<https://www.science-of-aesthetics.org>).

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Introduction

The relationship between creativity and alcohol is complex and far from fully understood. There is a myth surrounding the use of alcohol that is sustained by the dramatic acting out of individuals under the influence and the high number of creative individuals who have been publicly identified with abuse and addiction problems. The fuzzy notion that somehow alcohol improves creativity is based on the romantic misconception that these substances release inhibition allowing insights and creative achievement to flow. Very little objective research or self-reports from creative individuals support this idea.

In order to understand whether alcohol abuse is higher than average in creative people a baseline needs to be established. The World Health Organization estimated that in 2018 3.3 million deaths were alcohol related. This represent 7.6% of men who died and 4% among women.

Alcoholism is defined as repeated intake of alcoholic beverages to an extent that causes repeated or continued harm to the drinker.

Consequences of heavy drinking can include acute health problems, traffic injuries and deaths, accidental injury including alcohol poisoning, suicide, high risk sexual behavior, and violent crime. Specific health problems include cirrhosis of the liver, mouth cancer, pancreatitis, epilepsy, TB, colorectal cancer, hypertensive heart disease and breast cancer. There are also serious social and economic ramifications related to alcohol abuse.

Globally alcohol consumption continues to increase – 38.3% of the world population consumes alcohol but there are wide variances based on local cultures, socioeconomic factors and availability. Many Muslim countries, where there are primarily abstainers, have a very low percentage of alcohol dependence while other countries have very high levels of alcohol consumption, especially among men. Highest percentage consumption rates per capita are in countries in Eastern Europe including Belarus, Moldova, Lithuania, Russia and the Ukraine although consumption showed a significant decline from 2004 to 2018. One problematic trend worldwide is increased consumption per individual drinker.

This entry reviews the physical effects of alcohol as well as its influence on creativity. Research regarding the unusually high level of alcoholism in creative professions will be presented along with a discussion of the reasons. Finally the depiction of alcohol in the arts will be discussed.

Effects of Use

Physical Effects

Small doses of alcohol may help stimulate some aspects of brain function but alcohol is otherwise a depressant. *Encyclopedia Britannica* (2019) online stated that as more alcohol is consumed, an individual becomes more depressed, going on to sedation, stupor, and coma. The excitement phase exhibits the well-known signs of exhilaration, loss of socially expected restraints, loquaciousness, unexpected changes of mood, and occasionally uncontrolled emotional displays. This may result from an indirect effect of alcohol in suppressing the function of inhibitory brain centers rather than a direct stimulation of the manifest behavior.

[☆] *Change History:* July 2019. Steven Pritzker updated the text throughout.

This entry is a revision of the first edition article Alcohol, Substance Abuse and Drugs by Steven R Pritzker, volume 1, pp. 53–59, 1999, Elsevier Inc and Substance Abuse and Creativity in the second edition, volume 1, pp. 390–95.

Prolonged use of alcohol damages the health of many alcoholics. Consuming four drinks a day or more can cause high blood pressure, coronary heart disease and failure, and stroke. Prolonged alcohol use is also associated with brain damage and the development of neuropsychological disorders. Impairments may include deficits in short-term memory, disrupted cognitive and motor functioning, poor attention span, difficulties with problem-solving and learning new information, sexual dysfunction, and suppression of the immune system.

The lack of inhibition caused by drinking is directly linked to criminal behaviors, including physical violence and homicide. Legal problems as well as divorce also increase. Alcoholism can cause death from cirrhosis of the liver and impaired motor ability relating in alcohol related fatalities in automobile accidents, falls, and drowning. High levels of alcohol are found in 36% of suicides.

Effects of Use on Creativity

Some eminent creative people believed alcohol was a vital component in their success. The most common use was to overcome fear and anxiety. Aristophanes, in a play written in 424 BC, wryly commented on the benefits of alcohol: "When men drink, then they are rich and successful and win lawsuits and are happy and help their friends. Quickly, bring me a beaker of wine, so that I may wet my mind and say something clever." Dorothy Parker said, "Three highballs, and I think I'm Saint Francis of Assisi."

Other creative people drank to escape the difficulties of life. The sensitivity and awareness which made their work special also made them more prone to depression and a sense of isolation. In many cases, alcohol was used as a type of medication to dull the sharp edges of life. Tennessee Williams seemed to be speaking about his own depression and addiction when he had one of his characters in *Cat on a Hot Tin Roof* say, "Mendacity is a system that we live in. Liquor is one way out an' death's the other."

In some cases, creative professions may be the only work an alcoholic could do. The individual has the freedom to drink and work as a writer or painter. Maurice Utrillo, who struggled with alcoholism and depression, could not keep an ordinary job. He was encouraged to paint by his mother as a diversion from his alcoholism (Harris, 2005).

A sense that alcohol somehow contributed to their creativity (perhaps used as a justification for their drinking) helped demolish the long-term productivity or shortened the lives of many eminent creative people. Younger creative people still have the physical resilience to drink heavily and get their work done, but as they age it becomes more difficult, which is not surprising considering the physical effects of alcohol.

Of course, alcohol can deter productivity even when it is not used while an individual is working. Rothenberg defined three states of drinking for the writers he studied:

1. Early in their career, they only drink after work.
2. Drinking begins to occur during the day as the need for alcohol increases, which is the progression experienced by most alcoholics. In the case of writers, the loneliness of the job combined with the anxiety and uncertainty of the work can lead to a state of 'irritability.' Alcohol is used as a sedative which helps soothe frayed nerves.
3. The increased drinking results in a deterioration in the quality of the work.

Rothenberg cautioned that each case is individual and may be triggered by elements unconnected to writing such as genetics or family history. When the parent whom the writer lovingly and competitively identifies with is an alcoholic, then the dangers of alcoholism are particularly high. Examples include John Cheever and William Faulkner. F. Scott Fitzgerald summed up the danger of drinking in his work and life: "First I take a drink. Then the drink takes a drink. Then the drink takes me."

Experimental Research

Results of research using non-eminent participants indicated that drinking alcohol may exaggerate an individual's self-assessment of his or her work. One study found that as Aristophanes suggested, low doses of alcohol did not affect the quality of creative work, but participants who believed they drank alcohol *thought* their work was better. In another study, participants who thought they drank alcohol produced more creative combinations of wildflowers even if they had a placebo. This suggests that just thinking one has consumed alcohol may loosen some people's inhibitions.

A few researchers attempted to determine if alcohol facilitates creative writing under laboratory conditions. There are indications that alcohol significantly increases the number of words produced, confirming anecdotal accounts of writers who found alcohol an aid in producing work, but quantity does not necessarily equal quality (Gustafson and Norlander, 1995).

An experiment indicated some short-term benefits from alcohol consumption measured at 0.075 including improved creative problem solving abilities and better performance on the Remote Associates Test. (See Remote Associates) If alcohol does contribute to helping solve creative problems, at least on a short term basis, it would offer some explanation for its use by creative individuals (Jarosz et al., 2012) Another study measured the effect of alcohol on a placebo group, and an alcohol group during different phases of creativity with a lower alcohol rate of 0.03. The researchers concluded that the mildly intoxicated participants had less executive control but improved their creative problem solving ability compared to the placebo group. Divergent thinking ability was not influenced by the alcohol (Benedek et al., 2017).

Ludwig (1990) concluded 9% of his sample had helped their creativity by using alcohol; however, he cautioned that the perception alcohol helps creative work could be exaggerated by the properties of alcohol. He pointed to John Cheever, Eugene O'Neill, and Jackson Pollock as examples of creative people who gave up alcohol. However, no studies have examined how alcohol affects accomplished creative individuals under actual working conditions.

Extent of Use of Alcohol Among Eminent Creative People

Alcohol and creativity have been linked by the fact that many eminent creators have been alcoholics. [Table 1](#) is a partial list which is impressive because there are numerous eminent writers, artists, performers, and musicians.

The largest scale attempt to identify the level of alcoholism in eminent creative people was done by Arnold Ludwig, who in 1995 reviewed the lives of 1004 eminent people who had a biography reviewed in *The New York Times Book Review* between 1960 and 1990. He assessed alcohol dependence or abuse on the basis of physical problems, work interruption or poor performance, personal and interpersonal problems, and arrests. He found: "Among eminent people, 26% experience alcohol related problems during their lifetime, 23% of women and 27% of men." Creators in the arts were much more at risk: "Actors or directors, musical entertainers, sports figures, fiction writers, artists and poets (29% to 60%) have higher rates of alcohol dependence or abuse than natural scientists, soldiers, social scientists, social activists and social figures (3% to 10%)." (1995: 133–134).

These results are considerably higher than the 7.7% rate of combined alcohol abuse and dependence of alcoholics in the United States. Men greatly outnumber women and in contrast to eminent creators, rates of alcoholism declined with age rather than increased. Higher rates of alcoholism among creative artists, especially writers, were found in a number of other studies. One study found that 30% of the Iowa workshop for creative writers had a problem with alcoholism at some point in their lives. Another study found that female writers had an alcoholism rate of 20% relative to a control group rate of 5% (See Writing and Creativity).

[Rothenberg \(1990\)](#), who worked as a psychotherapist with some eminent writers, pointed out that higher rates of alcoholism in the creative arts could be encouraged by the nature of the work, which is often isolating and allows the individual writer or artist to drink more easily. Alcoholism is found less frequently in scientific professions where personal vision is less important than producing objective data that can be replicated.

Cultural conditioning plays a role in the entertainment business where alcohol abuse is a serious problem. High profile actors with acknowledged alcohol abuse issues include Mel Gibson, Bradley Cooper, Ben Affleck, and Drew Barrymore. The list of musicians includes Eric Clapton, Pete Townshend, Eminem, Billy Joel, Keith Richards and Ringo Starr. Some of these celebrities are now sober.

Amy Winehouse wrote a song called Rehab and inevitably there is a group with that name. Unfortunately many people such as Winehouse died before they got to rehab, or rehab did not work, and the list of early deaths of highly talented individuals is a long one.

Families of Alcoholic Creative People

Ludwig found 12.2% of the fathers and 2.4% of the mothers of eminent creative artists were alcoholic compared to 6.6% of the fathers and 0.5% of the mothers in other professions. Furthermore, 10.6% in the creative arts had alcoholic siblings compared to 6.3% of others. Other studies found that 11% of the writers had at least one alcoholic parent compared to 7% of the total sample. Examples of eminent creative people who came from alcoholic families include Charlie Chaplin, Tennessee Williams, Orson Welles, and Truman Capote.

The coincidence of alcoholism and other addictions in families is confirmed by genetic research. Sarah Hartz and Laura Bierer stated:

Robust genetic associations have been found for alcohol dependence, nicotine dependence, and cocaine dependence. (2010: 107)

As genetic research becomes more sophisticated, advanced techniques may eventually reveal if there is a genetic link between alcohol abuse and specific creative talents.

There is a paucity of research looking at alcoholism in families. In a study on painters, the only characteristic which differentiated excessive drinkers from moderate drinkers was having the same profession as their father. In one case, the son of a successful father exhibited anxiety over competition with the father. In another case, the son pursued painting to satisfy his father's unfulfilled ambition "at the cost of inner development and constant strain."

Alcoholism in the Arts

Alcoholism inevitably creates self-destruction and conflict which provides material for creative work. The fact that so many influential creative people were alcoholics led to prolific inclusion in songs, books, plays and films:

- Alcohol abuse is the theme in films such as *Lost Weekend*, *Barfly*, *Leaving Las Vegas*, *The Days of Wines and Roses*, *The Verdict* and hundreds of others. Alcohol and drug use are frequently depicted favorably in films; a review of movies released in 2016 showed 28 out of 33 movies had scenes where alcohol or drugs was consumed.
- Shakespeare addressed the perverse influence of alcohol in many of his plays. Award winning plays where alcoholism is a key element include *Long Day's Journey into Night*, and *Who's Afraid of Virginia Woolf*.
- Alcoholism is represented in novels such as *Under the Volcano* and *Postcards from The Edge*, memoirs from musicians, movies stars and everyday alcoholics, and biographies of alcoholic figures such as Ulysses Grant and Spencer Tracy.

Table 1 Eminent creative people thought to be alcoholic

Sherwood Anderson
Bix Beiderbecke
Mathew B. Brady
Robert Burns
William Burroughs
Richard Burton
Truman Capote
Raymond Chandler
Stephen Crane
e. e. cummings
William de Kooning
Theodore Dreiser
T. S. Eliot
William Faulkner
W. C. Fields
F. Scott Fitzgerald
Gustave Flaubert
Stephan Foster
Mel Gibson
Gluck
Ulysses S. Grant
Dashiell Hammett
Lillian Hellman
Ernest Hemingway
O. Henry
Victor Hugo
James Joyce
Frida Kahlo
Buster Keaton
Jack Kerouac
Stephen King
Sinclair Lewis
Jack London
Robert Lowell
Jim Morrison
Carson McCullers
Modigliani
Mary Tyler Moore
Mussorgsky
Richard Nixon
John O'Hara
Eugene O'Neill
Charlie Parker
Edith Piaf
Edgar Allan Poe
Jackson Pollock
Richard Rogers
Mark Rothco
Jean-Paul Sartre
John Steinbeck
Elizabeth Taylor
Dylan Thomas
James Thurber
Toulouse-Lautrec
Mark Twain
Maurice Utrillo
Tennessee Williams
Thomas Wolf

- Websites list hundreds of songs about alcohol in a variety of genres such as Beyoncé's *Drunk in Love*, Merrill Haggards *I Think I'll Just Sit Here and Drink* and *What Good Can Drinkin' Do* by Janis Joplin. A study of Billboard Magazine's biggest hits from 2005–07 identified 169 (21.3%) out of 793 songs that referred to alcohol. A review of YouTube pop videos in the UK indicated a prevalence of alcohol inspired lyrics and situations with an emphasis on the positive aspects of drinking. Research indicated the glamorization encourages adolescents to drink more so they can emulate their idols.

Also inherently dramatic is "Recovery" from alcoholism and drugs with its triumphant elements. It has been the subject of many books including Alcoholics Anonymous literature, memoirs of celebrities such as Elton John and self-help books by the score. Some recovery movies include *28 Days*, *My Name is Bill W.*, and *When a Man Loves a Woman*. Songs include two called *Sober* by Pink and Kelly Clarkson.

All this self-reflective activity by creative individuals suggests that using creative self-expression could be valuable in healing. There are recovery programs that are using expressive arts in a variety of ways to heal and transform individuals using art, writing, dance and music. Natalie Rogers (1993) suggested that expressive arts could help an addict achieve an altered state of consciousness replacing the need for mind-altering drugs (See Expressive Arts).

Summary and Conclusions

Reasons why the use of alcohol is more prevalent in creative professions include:

1. **Genetic predisposition:** A higher percentage of fathers, mothers, and siblings of eminent creative people were alcoholics.
2. **Self-medication:** More people have affective mental illness so they may be self-medicating with alcohol and other drugs.
3. **Opportunity:** Writers, artists, and composers often work alone so they can drink or use drugs more often without anybody knowing about it.
4. **Subculture:** Performers live in a subculture where alcohol and drugs are easily available and are a part of the culture. Previous stars who died dramatically and publicly from use of alcohol and drugs may be idolized and emulated by the next generation. In the case of musicians and actors, there may also be an element of trying to be a part of the culture of their younger audience as they found themselves aging.
5. **The Difficulty of the Work:** Creative work is tough and uncertain, and the road to success for most aspiring creators is paved with disappointment, self-doubt and rejection. Creative artists suffer blocks at times. Alcohol may provide temporary release from the self-doubt and pain.
6. **Stress:** Success brings its own pressure. Creators often feel they must match or exceed their previous work. Simonton (1994) proposed alcohol use may provide the user with a self-handicap, a convenient excuse that justifies failure. For performers such as musicians, comedians, and actors, the pressure of having to be at the top of your game because the stakes are so high can encourage some creative people, especially live entertainers, to use alcohol to overcome their performance anxieties, loosen their inhibitions and to wind down so they can sleep after being energized by their performances (Ludwig, 1995: 136–137)
7. **As an Aid:** Some creative people stated they felt alcohol helped their work, especially in overcoming anxiety during the initial stages of creation.
8. **Widening Consciousness:** The idea, reinforced by some creative individuals, that they use alcohol in an attempt to widen their consciousness and seek new perspectives.

Stephen King in his book *On Writing* wrote frankly about drug and alcohol problems: "The idea that creative endeavor and substances are entwined is one of the great pop-intellectual myths of our times." (in Hyde and Zanetti, 2002: 210). He acknowledged that, "Creative people do probably run a risk of alcoholism and addiction more than those in some other jobs, but so what? We all look pretty much the same when we're puking in the gutter."

The number of variables involved leave the relationship between creativity and alcohol with many unanswered questions. Far more work needs to be done to understand the physiological effects of using alcohol in relation to creative activity as well as the psychological dynamic. Innovative methods are needed to research this challenging field.

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Altered and Transitional States[☆]

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Glossary

Altered States of Consciousness An “altered” conscious state can be defined as a pattern of phenomenological properties recognizable by an individual (or group), or by an external observer of that individual (or group), as demonstrating a major difference in behavior and experience from an ordinary baseline pattern of wakefulness. An “altered state” involves changes in a number of “subsystems” of consciousness such as perceptions, cognitions, emotions, and sense of time and space. Both dreaming and non-dreaming sleep differ from baseline consciousness, thus qualifying as “altered states.” Others include variants in wakefulness resulting from meditation, prayer, hypnosis, “peak experiences,” “mediumistic” and “channeling” rituals, and more. Studying the phenomenology (or subjective experience) of an “altered state” can be accomplished through observation, self-reports, interviews, brain scans and other psychophysiological measures, or the administration of psychological tests and inventories

Consciousness The term “consciousness” derives from the Latin *conscire*, to know with, or to be cognizant of something. Ordinary waking consciousness reflects the explicit knowledge of one’s situation and one’s sense of personal existence. In general, “consciousness” can be described as a phenomenological pattern that characterizes humans or other sentient organisms at any given time and place

Creative The term “creative” can be applied to any act, idea, or product that changes or transforms an existing domain of human endeavor. A phenomenon is creative if it is novel and, in some manner, useful or appropriate for the situation in which it occurs

Phenomenology This is an approach to disciplined inquiry that emphasizes the nature of conscious experiences in their own terms. Phenomenologists investigate the relationship between conscious behaviors and the objects of such acts, thereby differing it from introspection

Transitional States of Consciousness Typically, a “transitional conscious state” lasts for a brief time period, mediating between two longer lasting patterns of consciousness. Hypnagogic states are transitional, because they mark the shift from a baseline state (wakefulness) to a long-lasting altered state (sleep). Other transitional states include daydreaming, reverie, napping, and hypnagogic or hypnopompic states, the former occurring when falling asleep and the latter upon waking from sleep. Transitional states are sometimes called “transliminal,” because they cross a “limen” or threshold

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Historical Overview

The terms by which people make sense of their world are social artifacts, products of historically situated interchanges among people. In the history of Western civilization, not all individuals have had equal opportunities for creative expression. For example, until recently the creativity of women was rarely valued or encouraged in Western cultures; women were given few occasions to develop the skills (e.g., critical thinking) or life circumstances (e.g., solitude) on which creative work often depends. One of creativity's "Four Ps" is Place, the historical and cultural context of Person, Process, and Product.

Shamans are community-sanctioned practitioners who purport to access information in what Westerners would call "altered states." Shamans then use this information in service of their community. For example, Pablo Amaringo, a Peruvian shaman, interacted with "spirits" after drinking ayahuasca, a mind-altering brew made from Amazonian plants. His paintings of the "spirit world" attracted the attention of tourists. Using funds from the sale of his paintings, Amaringo established an art school for young people from the Amazonian rainforest. Jeremy Narby, an anthropologist, took three scientists to the Amazon to imbibe ayahuasca under the guidance of shamans. All three reported creative insights that helped them solve problems relating to their work (Narby and Huxley, 2009).

The paintings in the Lascaux Caves of southern France date back at least 17,000 years; the prone figure depicted in the cave is often regarded as a shaman experiencing changed consciousness, perhaps dreaming. Cave art often depicts substances now referred to as "psychedelic" (from the Greek words *psyche* and *deloun*, i.e., "mind-manifesting"). Such substances as the peyote cactus apparently helped many shamans enter the "spirit world." Psychedelics provided a technology that triggered theatrical performances, mythic narratives, chants, songs, dances, and other products currently labeled "creative." Traditional Siberian shamans still "journey" to the "spirit world" with the aid of psychedelic mushrooms, ritualistic dancing, and/or rhythmic drumming.

Initiates of the Eleusinian Mysteries in ancient Greece probably used a potion containing a psychedelic fungus to fathom what the poet Pindar called "the end of life and its god-sent beginning." India's Vedic hymns sing the praises of *soma*, an intoxicant, perhaps a psychedelic mushroom, that was "all pervading, swift as thought."

In pre-Conquest Mesoamerica, people used their talents creatively in the service of their religious beliefs. Aztec poets and musicians rhapsodized about the "dream flowers" that took them to another world. Wasson found similarities between the employment of psychedelics in pre-Conquest Mexico and their use in ancient Greece; mind-altering plants adorn both the vases of Attica and the architecture of Mitla.

Cross-Cultural Comparisons

Societies have an assortment of terms to describe activities resembling what Western psychologists refer to as creativity; for example, the first hexagram of the Chinese "Book of Changes" (or *I Jing*) is *Ch'ien*, the "Creative Principle." Most Asian, African, and Native American traditions also have used creative imagination to enrich and enhance everyday life. Novel and original contributions were typically seen as gifts from deities or spirits who used humans as "channels."

When the Catholic Church's power was dominant, Western cultures tended to consider "channeling" wicked and demonic. Following the Renaissance, science and medicine prevailed. However, the rituals of "mediums" and "channelers" were now cast in psychopathological terms, even though their phenomenology was quite different. In contrast, traditional Eastern worshippers, such as Buddhists, Hindus, and Taoists, had intricate vocabularies to describe the phenomenology of changed consciousness.

In dreams and in waking visions, the Maya people asked their deities to appear before them, reflecting a tradition of visionary ecstasy. Mayan artists depicted an overlap between the world of everyday reality and the "spirit world," suggesting that their phenomenology was more "dreamlike" than that of their European conquerors. Freud described the conscious "ego" as the external boundary of a volatile reservoir of both conscious and unconscious "psychic energies." This resembles the shamanic energetic model of the human body embedded in a community and environmental matrix. However, from the shaman's perspective, the "unconscious energies" of the Freudians were not blind and irrational, but keenly intelligent forces originating in the earth itself.

Creativity and Psychedelics

Psychedelic substances and other drugs affect consciousness by modifying the process of synaptic transmission in the brain. Excitatory and inhibitory connections are carried out by transfer of biochemicals (by neurotransmitters) across the synaptic gap between neurons. Drugs can affect synaptic transmission in a variety of ways, such as blocking the production or reception of a neurotransmitter or mocking a neurotransmitter, thus effectively increasing its activity level. The phenomenological pattern that a drug evokes depends upon which neurotransmitters it affects. In the case of psychedelics, the outcome seems to be a disruption of logical analysis and the automatic reality-checking functions of the brain, probably connected to the ability of these drugs to block serotonin transmission. In psychotherapy, psychedelics can produce a depatterning influence that breaks up the individual's habitual experiences of the world, tending to increase the individual's suggestibility and susceptibility to reprogramming (Baruss, 2003).

Several creative individuals have produced anecdotal accounts claiming that their phenomenology has been affected by ingestion of psychedelics (Krippner, 2017). They include neurologist S. Weir Mitchell, British writer Aldous Huxley, U.S. naval technician John Busby, actors Cary Grant and Rita Moreno, and the Canadian architect Kyo Izumi. Both Kary Mullis and Francis Crick attributed their Nobel Prize-winning discoveries (i.e., a DNA detection method; the double helix structure of DNA), at least in part, to experiences with LSD.

The “Model Psychosis” Assumption

Some early researchers reported that LSD users gave highly imaginative, although bizarre, responses to Rorschach inkblots and other measures. In summarizing his observations of LSD users in 1976, the psychoanalyst Silvano Arieti found that the use of “primary process mechanisms” was enhanced, but that the “secondary processing” required to put the imagery to creative use was impaired. These studies and related research, conducted with artists and non-artists, and with laboratory participants and “street users,” identified many dysfunctional results of informal psychedelic drug use. However, no conclusive data supported the notion that psychedelics could produce a “model psychosis.” In 1988, T. E. Oxman and colleagues reported a content analysis of 66 autobiographical accounts of schizophrenia, psychedelic drug experience, and mystical experience, as well as personal experiences in ordinary consciousness. They concluded that there is a “clear dissimilarity” among changed states of consciousness, especially between psychosis and psychedelic drug states, as a refutation of the “model psychosis” perspective. Creativity, of course, is only one of many behaviors affected by psychedelics. One of creativity’s “Four Ps” is Process, and psychedelics may accelerate the incubation phase.

Psychedelic Research With Volunteers

Another of creativity’s “Four Ps” is Person, and several studies have been conducted with volunteers to determine the relationship between psychedelics and creative behavior. For example, to study the effects of LSD on creativity test scores, a test battery (also administered to a control group) was given before LSD ingestion, and alternative forms of the same tests were administered 2 h later. The researchers observed that changed scores on the creativity tests favored the LSD group, even though they did poorly on tests requiring visual attention. In another study, one-third of the participants were administered a high dose of LSD, one-third a low dose, and one-third an amphetamine. Questionnaires were administered to each group prior to drug ingestion and again at two follow-ups. The low LSD and amphetamine groups obtained similar results, but the high LSD group bought more musical records, spent more time in museums, and attended more musical events. Another study dispensed psilocybin to volunteers who had completed tests for creativity and for brain damage; they were re-tested after drug ingestion. A significant inverse relationship between the scores on the two tests was reported.

A 2018 study found that both convergent and divergent thinking test scores improved following frequent “microdoses” of LSD. In summation, psychedelic substances affect several subsystems of consciousness that enhance creativity (Pappas, 2018). However, these insights need to be implemented in the elaboration phase of creativity.

Psychedelic Research With Selected Participants

In the 1960s, LSD was administered to 50 well-known artists at the Max Planck Institute in Munich. The artists concurred that the experience was of value, and the ensuing work was displayed in a Frankfurt gallery. In a study on the effects of mescaline and LSD on four U.S. graphic artists, a panel of art critics judged the paintings to have greater aesthetic value than the artists’ usual work, noting that the lines were bolder and the use of color more vivid. A similar study giving LSD to American artists resulted in judgments by a professor of art history that the LSD paintings were more imaginative, especially in color, line, and texture, although the technique was poorer.

A study of professional workers in creativity-related fields showed that mescaline ingestion resulted in a statistically significant increase in creativity test scores, with enhanced fluency of ideas, visualization, and field independence. Interview and questionnaire data revealed that half the group had accomplished a great deal more during the mescaline session than would have characterized their ordinary workday. All participants reported positive reactions to mescaline, but many were unable to focus because they were diverted by the experience itself.

In one study, ayahuasca was ingested by 24 volunteers. Their pre-session and post-session scores on creativity tests revealed a decrease in convergent thinking and an increase in divergent thinking. The researchers concluded that ayahuasca “enhances creative divergent thinking,” but that “additional research ... is warranted” (Kuypers et al., 2016, p. 3407).

Cross-Cultural Considerations

The potent red mescal bean, *Sophora secundiflora*, has been found with the remains of the extinct bison and the tools and weapons of early North American hunters. Anthropologists have noted that the chants and poems used in contemporary spiritual ceremonies make great demands on the practitioner; the Yakut shaman in Siberia, for example, has a poetic vocabulary of some 12,000 words used in *Amanita muscaria* mushroom rites, as compared to 4000 in ordinary daily endeavors. The Zuni rain priests of New Mexico have a special language with which they converse with “spirit birds” once they have ingested *Datura meteloides*. For native people, these substances are not taken trivially, for momentary pleasures or “cheap thrills” (De Rios, 2003). To maintain their standards, native groups require a precise amount of time for the preparation of psychedelic concoctions, and the mixture of ingredients must be exact. Even then, there may be an initial period of bodily discomfort, physical pain, or vomiting, followed by encounters with “malevolent spirits.”

Psychedelics often foster creative behavior among indigenous people by reinforcing cultural myths and traditions. The ayahuasca-ingesting Siona shamans of the Amazon have provided phenomenological reports that involve categorizing the induced visions into

culturally meaningful symbols and experiences. On the other hand, psychedelics often stimulate creativity among specialists in industrialized societies by *deconditioning* them to their cultural traditions; their images are likely to tap into their personal rather than their social *imaginario*.

Creativity, Hypnagogia, and Hypnopompia

Colorful images often occur during hypnagogic (from the Greek *Hypnos*, or sleep, and *agogeus*, or leading into) reverie, the transitional state occurring during the onset of sleep. There is a similar association between creativity and hypnopompic (from the Greek *Hypnos*, or sleep, and *pompe*, or leading out of) reverie, which occurs as one awakens from sleep. These transitional states, referred to as hypnagogia and hypnopompia, resemble dreams in that both contain visual, auditory, and/or kinesthetic imagery. However, material from these twilight states is not typically characterized by narration, as with dreams (Mavromatis, 1987).

Hypnagogic images seem to have been a critical factor in chemist Friedrich August Kekule's conceptualization of the structural formula of the benzene molecule as well as a Ludwig van Beethoven composition obtained while napping in his carriage en route to Vienna. William Blake claimed that images of spiritual beings, which started coming to him as a child, served as the basis for many of his later drawings. Thomas Edison often stretched out on his workshop couch; during these "half-waking" episodes, he claimed that he was "flooded" by creative images. Mary Shelley disclosed that her classic tale, *Frankenstein*, came to her as a series of hypnagogic images the evening after her group of friends agreed to compete for the best original Gothic horror tale (Shelley won).

Creativity and Daydreaming

Autobiographies and biographies reveal that several prominent individuals apparently utilized various types of daydreaming for creative purposes. Isaac Newton claimed to have solved many vexing problems in physics when his attention was waylaid by private musings.

The composer Claude Debussy used to gaze at the river Seine and its playful reflections of the sun to establish an atmosphere for his creativity. The writer Friedrich Schiller kept rotten apples in his desk drawer, stating the aroma helped evoke creative reverie. The philosopher John Dewey observed that creative conceptions frequently occur when people "are relaxed to the point of reverie." Jerome Singer (1966) found evidence in both children and adults of frequent daydreaming among those whose written or dictated stories were rated by judges as the most original and creative. Singer also reported that daydreaming was marked by passive, effortless indulgence of a wish in fantasy an uncritical condition typical of some types of creativity.

Cross-Cultural Comparisons

The way a culture conceptualizes creativity restricts it to some social practices and processes and denies it to others. During the heyday of Maoist thought in China, creativity was a matter of teamwork, and no individual artisan was allowed to sign a painting, claim authorship for an orchestral piece, or register credit for an invention. For spiritual reasons, the composers of Indian ragas did not affix their names to their works, and, in the Benin culture, the African deity Olokun is thought to influence artists through dreams and reverie. There are several societies in which specialists are encouraged to put aside their rational problem-solving modes of thought so that divinities may work through them.

Creativity, Meditation, Hypnosis, and Mediumship

There are psychophysiological markers for hypnagogia, hypnopompia, and napping. In the case of meditation, several studies have identified markers such as reduced respiration rate and volume of air breathed, reduced oxygen consumption and carbon dioxide elimination, and reduced blood lactate. In these studies, heart rate and the skin's electrical conductance decreased, but the frequency of alpha (and sometimes of theta) brain waves increased. All of these suggest reduced energy metabolism, autonomic nervous system arousal, cortical energy metabolism, and autonomic nervous system and cortical arousal. Reduced arousal during meditation is due to its rest and relaxation aspects rather than to the specific meditation practice employed. However, it is probably more accurate to speak of "meditative states of consciousness" than to hypothesize a single "meditative state," because different practices may emphasize rapid breathing and active movement rather than counting breaths, repeating phrases, focusing on a mandala, or witnessing to one's thoughts (Csikszentmihalyi, 1996).

The term "hypnosis" refers to a variety of structured, goal-oriented procedures in which the suggestibility and/or motivation of an individual or a group is enhanced by another person (or persons), or by oneself. These procedures attempt to blur, focus, and/or amplify mentation (e.g., imagination and intention), leading to the accomplishment of specified behaviors or experiences that reflect expectations and role enactments on the part of the "hypnotized" individuals who attend (often with little awareness) to the interpersonal or situational cues that shape their responses. Other research data emphasize the part that attention plays in hypnosis, enhancing the salience of the suggested task or experience. Both these bodies of hypnosis literature stress the interaction of several variables, suggesting that there are great individual differences in hypnotic responsiveness. Some participants are fantasy-prone, others dissociate easily, and still others are highly motivated to be "hypnotized." Both hypnotic susceptibility and creativity

are fairly stable personality traits, as measured by several standardized tests. The research on hypnosis and creative phenomena has shown that fantasy and absorptive experiences are concomitants of various changes in consciousness, including those due to hypnosis. They occur spontaneously in the context of a creative act; and they are often experienced by creative participants who, as a group, seem more adept than their less creative peers at shifting cognitively from a higher to a lower level of psychic functioning – from a more active to a more passive condition. In addition, the ability to tolerate unusual experiences and become absorbed in a variety of experiences correlates highly with hypnotic susceptibility. Time distortion in hypnosis has been used to facilitate the expressive arts and creative writing (Cooper and Erickson, 1954). Benefits from hypnotically enhanced rehearsals have been reported by actors and performing artists (Shames, 1992).

Because of the link between hypnosis and creativity, practitioners need to know with what degree of facility a hypnotized subject can produce pseudo-memories. Even if the increase in memories later is found to be accurate, it is often accompanied by an increase in inaccurate memories. These pseudo-memories attest to the participants' creativity but are often used inappropriately in psychotherapy.

The term "meditation" (from the Latin *meditatio* or thinking over) refers to a variety of practices that are used to self-regulate one's attention. All meditative practices attempt to bring the meditator into the "here and now," breaking through habitual phenomenological patterns. The case for increased creativity during meditation rests on the practice's ability to assist the meditator to break through socially ingrained patterns of perceiving and conceptualizing the world (Murphy and Donovan, 1988). If the linear, cause-and-effect way of thinking can be transcended, creativity may result. Creativity may be further enhanced by adopting a more circular way of thinking in which the focus is on relationships, possibilities, and recursive patterns rather than on linear causality and single-outcome events (Csikszentmihalyi, 1996). The research on meditation and creativity has produced mixed results. One group of researchers found no relationship between creativity test scores and experience in meditation. Another group reported significant increases in creativity scoring among practitioners of transcendental meditation (TM) and among Zen meditators. One of the latter studies focused on students of Zen koans, finding that they were able to eliminate prior approaches interfering with problem solving and enhance the unification of contradictory events.

Patricia Carrington has reported several cases of students whose grades have improved, whose emotions have stabilized, and whose artistic productions have flourished following their initiation of a meditation practice. At the same time, in a comparison of a group of teachers of TM with a group of non-meditators, the former did no better than the latter on most measures, worse on a few measures, and better on one measure – an open-ended task requiring them to make up a story. It seems that meditation may enhance the free flow of associations and evoke new ideas for a meditator, but an abundance of meditation (probably the case with the group of teachers) may interfere with a person's logical problem-solving capacity. A meta-analysis of all existing studies of TM and "self-actualization" concluded that the magnitude of the effects was not due to expectation, motivation, or relaxation, but to TM practice itself (Carrington, 1978).

Chico Xavier was a Brazilian medium who claimed to receive information from deceased persons ("spirits"), most of whom he had never met. By the time that he died in 2001, Xavier had written thousands of letters and nearly 500 books, all purportedly dictated by "spirits." A linguistic analysis of several of these books found no underlying similarities among the purported authors or with the writings of which Xavier claimed ownership (Playfair, 2010). Occasionally, someone who is not a professional medium will produce poems, essays, and books through automatic writing. In 1913, a Missouri housewife, Pearl Curran, was using a Ouija Board when a message arrived from "Patience Worth" who allegedly lived in the 18th century. Over two decades, Curran produced over 400,000 words "dictated" by Patience Worth. Some were historical novels that received acclaim from both literary critics and historical scholars. Curran wrote a detailed phenomenology of her "automatic writing," describing how images came to her while she was fully aware and never in a "trance" state.

Cross-Cultural Comparisons

Eastern and Western meditative practices have a long history; they have been viewed as spiritual exercises – means for attaining the special kind of awareness that can be arrived at in concert with other life practices. In contemporary industrialized societies, however, meditation tends to be oriented toward practical goals, with no ties to a specific belief system. The advantage is that one is free to use meditation outside a spiritual context, combining it with other methods of self-development and health-oriented or psychotherapeutic treatment. The disadvantage is that one may not attain the peace of mind of the unitive "bliss" claimed by members of traditional meditation schools.

The history of hypnosis is more recent. In the middle of the 19th century, James Braid introduced the term "neuro-hypnotism" or "nervous sleep" (from the Greek *hypnosis*, or sleep). However, the roots of hypnosis reach back to tribal rites and the practices of shamans. Hypnotic-like procedures were used in the court of the Pharaoh Khufu in 3766 BCE.; priests in the healing temples of Asclepius induced their clients into "temple sleep," and the ancient Druids chanted over their clients until the desired effect was obtained. Herbs were used by native shamans to enhance verbal suggestion in pre-Columbian Central and South America. It is, nonetheless, incorrect to label these procedures "hypnosis" simply because they drew upon similar procedures such as suggestion, repetitive stimuli, and client expectations. People, groups, and cultures are "creative" during those periods of time when they exhibit activities that are innovative for that specific group in ways it considers valuable. These novel concepts, objects, and behaviors (e.g., a scientific discovery, a mathematical theorem, a philosophical insight, an artistic masterpiece) can be considered creative, although one social group might arrive at a consensus different from that of another group.

The practice of mediumship varies from culture to culture. The enslaved Africans brought their religions with them to the New World. Since such practices were vigorously opposed by Christian clerics, they went underground. This was a successful strategy in the French, Spanish, and Portuguese colonies; currently, mediumship is being practiced in New Orleans, the Caribbean, and Brazil, often in a temple that represents a syncretic religion (such as Candomblé or Santería). Some church members are renowned for “incorporating” famous artists, selling the artwork both to local people and to tourists.

Neurophysiological Mechanisms

Art involves the controlled structuring of a medium or material to communicate as vividly as possible the artist’s personal vision of experience. If the Product (one of the “Four Ps”) resonates with a larger public, it has succeeded in filling some gaps in social knowledge or in resolving cultural contradictions. Artists also attempt to supply missing information or material in a culture’s legacy. The same can be said for those creative individuals who work with institutions and groups of other people. None of this labor is done in a vacuum; there are neurophysiological predispositions interacting with social and psychological variables in the development of a Product, Process, Person, or Place that is eventually deemed creative.

There are several perceptual mechanisms ordinarily driven by sensory input during one’s baseline state of consciousness that are decoupled, totally or partially, from sensory input during many alterations in consciousness. A total decoupling takes place during dreaming, while partial decouplings take place in hypnagogic or hypnopompic states, daydreaming, meditation, and some drug-induced or hypnosis-induced conditions. Transitions from such states represent a fertile ground for the development of creative ideas, because the perceptual mechanisms automatically linked to organizing the sensory inputs still occur, occasionally constructing novel and useful images from fragments of internal neural noise and loosely guided consultations with memory. Language allows the abstract images and relationships to be translated into a communicable form (Fink et al., 2009).

There is a direct relationship between perceptual processes and creative thought. The decoupling of normal sensory input during changed consciousness can be viewed as distinct from restricting sensory input in an individual’s ordinary waking state.

Psychosocial Mechanisms

The forms in which creative experiences are expressed cannot be separated from individuals and their cultures. Cross-cultural research has demonstrated that patterns of expectation within a given culture have an *a priori* influence on creative experiences. Thus, in those cultures where women are devalued, there is little opportunity for their creativity to be expressed and appreciated.

The effects of psychedelics upon creativity depend on more than their neurophysiological effects, which are produced by an interaction between pharmacological drug factors (type or dose), long-term psychosocial factors (culture, personality, attitudes, knowledge, beliefs, prior experience), immediate psychosocial factors (mood, expectations, group ambience), and situational factors (setting, instructions, implicit and explicit demands). For example, anthropologists who have observed the effects of *ayahuasca* among indigenous people in the Amazon comment that the phenomenology differs, sometimes strikingly, according to the environmental and ceremonial background against which the drug is taken, the ingredients used in its preparation, the amount of it imbibed, and the expectancies on the part of the participant.

Learning From the Past

The formal study of creativity dates back only to J. P. Guilford’s 1950 presidential address to the American Psychological Association, in which he urged his colleagues to pursue this overlooked area. After the connection between changed states of consciousness and divergent thinking was made, and investigations of the links among drugs, hypnosis, and creativity ensued, studies of additional altered and transitional states followed.

A seminal research project was undertaken by R.K. Siegel (1977). He conducted a systematic study of visual images produced by a variety of drugs, focusing on such varied dimensions of these images as color, movement, action, and form. Siegel’s participants were trained to use an image classification system prior to the drug sessions. There were baseline and placebo sessions for comparative purposes. Regarding reported images, the amphetamine (a stimulant) and phenobarbital (a sedative) sessions did not differ from placebo sessions. However, the sessions with mescaline, LSD, psilocybin, and a marijuana derivative produced similar images. In the psychedelic drug sessions, for example, complex images did not appear until well after there was a shift to lattice tunnel forms; memory images emerged in the later stages of the appearance of complex imagery. Noting that hypnagogic and hypnopompic images were accompanied by theta and low-frequency alpha brain waves, other researchers used biofeedback to teach participants how to obtain this phenomenology. There was an expected increase in the participants’ awareness of internal imagery and dream recall. What was unexpected was that most of them reported an increase in “integrative experiences” and “feelings of well-being.” These positive changes were amenable to intuition, insight, and creativity.

Several questions regarding the research on hypnosis and creativity remain unanswered. Robust findings are lacking due to methodological differences in the studies, the varied hypnotic responsiveness of the participants, and the disparate ways that creativity has been measured. Even when similar tests are used, they are administered differently, and the tests themselves admittedly assess a single instance or aspect of creativity. It may be that restrictions in awareness increase the priming of associative networks (outside of one’s awareness) by reducing cognitive interference. As a result, new associations are made, giving rise to creative insights.

Imagination or fantasy provides a continuous backdrop to mentation outside of awareness, and hypnosis may increase its accessibility. Heart rate probably reflects shifts of attention from external to internal events, making it a potentially revealing way to assess the oscillation of attention from an external focus of concern toward the internal events it triggers, a process that is one aspect of creativity. A significant relationship has been reported between heartbeat rate variability and participants' creativity scores, as more creative persons tended to show higher cardiac variability.

The psychophysiological studies of Zen meditators and yogic meditators revealed basic differences: members of the former group demonstrated "openness" to external stimuli, but were not distracted by them, whereas members of the latter group demonstrated "detachment" from external stimuli. In the light of this diversity, it is important that the type of meditation studied be identified in the assessment of phenomenological accounts, as well as the length of time the participants had been meditating. Further, it is common for meditation to blend into sleep during an experiment; hence, the images reported may be the result of hypnagogia or hypnopompia and not meditation itself. The application of chaos theory to the study of creativity has produced several insights, among them a description of how chaotic activity patterns in the brain can reconcile convergent and divergent problem-solving processes, and how "chaotic attractors" can utilize the brain's neural networks to combine images and thoughts that would escape detection during wakefulness.

Planning for the Future

It is customary to study "the four Ps of creativity": product, process, person, and place (sometimes called press). Simonton added a fifth P, persuasion. And this entry has added another "P," namely, phenomenology. One's experiences, whether ordinary, altered, or transitional, often play a key and pivotal role in evoking creativity as well as sustaining creative behavior.

Future research might identify the extent to which individual differences determine the scope of creativity. Such data could provide a better grasp of the degree to which information processing in altered or transitional states constitutes a major source of creative productivity. Mental constructions occurring during such states can be useful only insofar as they are remembered in order to be evaluated for application and utility. It may be that the degree to which decoupled automatic perceptual processes contribute to creative output has far more to do with facility in higher-level cognitive processes (such as memory storage and retrieval, search, and comparison) than in individual differences in the perceptual organization processes themselves.

One common view of why individuals manifesting some of the streams of schizophrenic-like thought might be viewed as creative is that deficiencies in their customary involuntary perceptual organization processes lead to an increased likelihood of an atypical representation of a perceptual event. In other words, it may be the anomalous organization of sensory input, coupled with sufficiently appropriate higher order processes to evaluate the potential value of a mental construction, that lead to creative output. Creativity attributable to looseness in perceptual organization in the presence of stimuli is very different from creativity attributed to perceptual organization processes decoupled from normal sensory inputs. An increased frequency of transitions from transitional states of consciousness, as might reasonably be expected to occur in association with certain psychotic disorders, may be combined with unimpaired, or even superior, mechanisms of perceptual organization. This would represent a potential alternative route for contributing to creative thought by those individuals who are disposed toward cognitive disorders. Moreover, the relative instability or looseness in organizational processes, in tandem with the ability to exploit involuntary organizational processes decoupled from sensory input, may display individual difference variables. In this regard, what Richards (2018) has dubbed "everyday creativity" is an overlooked phenomenon in a field that all too often emphasizes the exotic, the dramatic, and the spectacular. It is quite likely that creative work draws more upon the ordinary waking state with its intact subsystems of consciousness than upon altered and transitional states.

Drugs can be ingested, meditation can be practiced, hypnosis can be utilized, and the contents of reverie can be recorded, but everyday behaviors and experiences can also provide inspiration for what later may become a novel approach to a long-delayed home refurbishing, an improved golf stroke, a new recipe for a family dinner, a breakthrough in a troubled relationship, an ingenious plan to divert restaurant leftovers to homeless people, a challenging educational technology, or any one of many other achievements.

The need for creative approaches at all social levels, as well as from all phenomenological states, has never been greater. Their development and application need to reflect the concepts of "origin" and "making," which have so appropriately grounded the Latin word *creare*.

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Analogy

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Glossary

Analogy Comparative statements of similarity

Cases Personal experiences involving activity in a domain

Categories Concepts used to organize events applying in some domain

Concepts Abstract principles used to organize knowledge in a domain

Conceptual combination The process of reorganizing extant knowledge to produce new knowledge

Creative processes Processes that need to be executed to produce a creative problem solution

Exemplars Prototypic, or typical, members of a category

Expertise Organized knowledge acquired through experience

Knowledge Facts bearing on a problem

Creativity has been defined in different ways by different investigators. The standard definition of creativity, however, holds that creativity involves the production of original, high quality, and elegant solutions to complex, novel, ill-defined, or poorly structured, problems. The need to produce solutions to novel problems, albeit, potentially problems that are only novel to the particular person engaged in the problem-solving effort, has an important, often overlooked, implication. To generate novel problem solutions, people must in some way formulate new knowledge to be used in generating original ideas for problem-solving.

This straightforward observation, however, begs a new question – one fundamental to understanding creative thinking. How do people go about formulating new knowledge? The answer most commonly provided to this question is new knowledge is created through the combination and reorganization of extant knowledge structures (Finke et al., 1992). Although the bulk of the available evidence supports this proposition (e.g. Mobley et al., 1992), yet another question arises. Exactly how do people go about combining and reorganizing extant knowledge structures? In other words, what are the cognitive operations involved in conceptual combination and reorganization?

Although many operations might be involved in conceptual combination and reorganization, it appears the key mechanism involved is analogical reasoning. Analogical reasoning involves identifying the *similarity* between multiple objects, events, or knowledge structures. In its' most simple form, analogical reasoning involves a statement A is similar to B based on this, or these, shared features, or attributes, of the objects of concern. For example, Zeus is to Jupiter as Venus is to _____. Aphrodite is the correct answer if one assumes the feature here is Greek and Roman gods. In the present effort we will examine how analogical reasoning contributes to conceptual combination efforts.

Analogy used in cognitive processing give rise to structuring and mapping activities necessary in complex problem-solving efforts. Gentner et al. (2001) discuss the use of mapping and analogical reasoning when generating mental models, a cognitive product used to make sense of the world. Moreover, the use of these analogies, particularly the use of multiple analogies, seems critical to reasoning and problem-solving efforts, as they enhance understanding of complex phenomenon.

Additionally, it appears analogical reasoning contributes to problem-solving efforts across multiple domains. Work by Sternberg and Nigro (1980) suggests that strategies employed may differ across individuals, perhaps due to expertise, but that analogies are beneficial for problem-solving regardless of the context. Thus, one might expect analogies to be beneficial in contexts calling for creative problem-solving.

Knowledge

Seeing similarities between concepts or events, of course, requires knowledge bearing on those concepts or events. In fact, a wide variety of studies have shown knowledge, or expertise, is, in fact, critical to creative performance. In one study along these lines, Vincent et al. (2002) asked some 1800 military officers to solve a set of military problems calling for creative thought where judges appraised the quality and originality of problem solutions, along with officer's ability to address critical incidents arising in the course of their work and their success in executing various creative thinking processes. Expertise was measured by asking participants to sort tasks into relevant leadership concepts and the accuracy of these task sorts was established based on their similarity to a theoretical model of military leadership. It was found this measure of expertise, along with measures of intelligence and divergent thinking, contributed, strongly contributed, to execution of various creative problem-solving processes, and in turn, contributed to production of creative problem solutions, original and high-quality solutions, as well as subsequent critical incident performance.

Although studies have demonstrated the impact of knowledge on creative problem-solving, they do not speak to the content of the knowledge people use in solving creative problems. This issue has been addressed in a study by Hunter et al. (2008). In this study, undergraduates were asked to develop a new course intended to prepare high school students for college where judges appraised the quality, originality, and elegance of these course proposals. Prior to working on these course proposals, however, participants were primed, through instructional manipulations, to use schematic, or conceptual, knowledge, case-based, or experiential, knowledge, or associational knowledge. It was found the most creative problem solutions emerged when people used conceptual knowledge or case-based knowledge in problem-solving, or a combination of conceptual and case-based knowledge.

Processes

Of course, if available concepts and cases allowed people to solve problems unto themselves, there is no need for creative thought. Instead, in creative problem-solving, it is held extent knowledge must be reshaped, or reformed, to produce viable solutions to novel problems. Accordingly, a key question confronting students of creativity has been how do people work with knowledge to produce novel problem solutions? The ways people work with knowledge in problem-solving has been discussed in terms of creative thinking processes. Over the years, many models of peoples creative thinking processes have been proposed.

Mumford and colleagues (e.g., Mobley et al., 1992) reviewed the various models of creative thinking processes that had been proposed over the years. They identified eight core processes commonly proposed in these models: 1) problem definition, 2) information gathering, 3) concept/case selection, 4) conceptual combination, 5) idea generation, 6) idea evaluation, 7) implementation planning, and 8) adaptive monitoring. Each process produces products needed for successful execution of the next process. And, execution of any given process was held to involve multiple cognitive operations with some operations, for example identifying procedures in problem definition, contributing to more effective process execution and thus better creative problem-solving. Execution of each process, moreover, was held to require evaluation of product outputs with people cycling back to earlier processes if an output was found to be inadequate.

In an extensive, ongoing, set of studies Mumford and his colleagues have acquired a substantial body of evidence supporting the validity of this process model (e.g., Mumford et al., 1997a). Broadly speaking, the findings obtained in these studies indicate that 1) effective execution of each of these processes makes a unique contribution to prediction of performance on creative problem-solving tasks, 2) effective execution of these processes contributes to performance on creative problem-solving tasks drawn from multiple different domains of performance, 3) effective process execution is strongly related to creative problem-solving ($r = 0.50$ with reliabilities in the 0.70s), 4) effective process execution adds to the production of creative problem-solving performance above and beyond standard abilities such as intelligence and divergent thinking, 5) each process involves multiple mental operations – thus in information gathering people must search for facts and anomalies with respect to these facts, 6) errors flow through these processes – thus an error made in problem definition disrupts information gathering, and 7) effective execution of these processes depends not only on mental operations but also the nature of the knowledge on which these operations are executed.

This model is noteworthy for a number of reasons. For example, it indicates idea generation occurs relatively late in a cycle of creative problem-solving activities. It implies idea evaluation is an active, constructive, process requiring self-criticism and reflection. Perhaps, most centrally, it suggests that the new knowledge needed to propose solutions to novel problems arises from, or is based on, the conceptual combination process.

Conceptual Combination

In an initial set of empirical studies into the role of conceptual combination in creative thought, Maier and Thurber (1970) presented undergraduates with fragmented word pairs (e.g., shoe, glove) and asked them to combine these words to generate a story. They found that participants regrouped and reorganized these words to generate creative stories. Moreover, creative stories based on these word combinations could not be accounted for by simple word preference.

Somewhat more recent evidence bearing on this importance of conceptual combination in creative problem-solving was provided in a study by Mobley et al. (1992). They presented undergraduates with 15 category combination problems. On these

problems, participants were presented with three taxonomic categories defined by four exemplars of this category (e.g., birds, robins, sparrows, owls, ostriches). They were asked to combine these categories to generate a new category, provide a label for this new category, provide additional examples of category members, and write a story using this new category. Judges were asked to appraise the originality and quality of the new categories formulated in this category combination task.

In working through these conceptual combination problems, two studies were conducted where various manipulations occurred in the nature of the material presented. Category similarity was manipulated, category content (e.g., biological or artifactual) was manipulated, and exemplar typicality (e.g., robin vs ostrich) was manipulated. It was found that presentation of more diverse categories and categories defined by atypical exemplars resulted in the production of more creative new categories, more creative category exemplars, and more creative stories. Thus conceptual combination does appear to contribute to creativity.

Confirmation of this observation was provided in another set of studies by [Finke et al. \(1992\)](#). In these studies, participants were presented with a number of different shapes – for example a hook and a block. They were asked to combine these images in such a way as to create new tool. It was found that skill in combining these images was positively related to the creativity of the new tools produced. Moreover, certain conditions were found to influence the production of more creative new tools – for example asking participants to think about applications or asking participants to elaborate on their initial designs.

In fact, these findings are in no way unique. [Owens \(1969\)](#) attempted to develop a test to select engineering students for creativity. On this test, participants were presented with mechanical objects (e.g., gears) and power sources and asked to combine these parts to design a new machine. What is of note is scores on this domain specific measure of conceptual combination proved strongly ($r = 0.40$) related to standard measures of creativity in engineering such as patent awards. Thus conceptual combination not only exists as a unique processing activity, it appears to be a viable predictor of creative achievement.

Analogies

[Baughman and Mumford \(1995\)](#) sought to identify the key analogical reasoning operations people must execute as they seek to combine and/or reorganize given knowledge to create the new knowledge needed for idea generation. More specifically, they argued that conceptual combination requires 1) a search for key features of each category, 2) mapping of shared and non-shared features of each category onto each other, 3) combination of shared and non-shared features, and 4) elaboration on new features arising from combinatory activity.

In the [Baughman and Mumford \(1995\)](#) study, participants were asked to solve a series of category combination problems drawn from [Mobley et al. \(1992\)](#). After generating their new category, participants were asked to provide a label for this category and generate a list of additional exemplars of this new category. Judges appraised new category labels and exemplars for quality and originality. As participants began work on these problems, however, they were presented with instructions to encourage feature search, feature mapping, feature combination, and elaboration under conditions where more or less similar categories were presented.

It was found that feature search, search for shared and non-shared features, of the stimulus categories and mapping of shared and non-shared features of these categories, contributed to the production of higher quality, and more original, new categories and category exemplars. It is of note, however, these effects emerged only when feature search and feature mapping occurred in tandem – participants were instructed to do both the search and mapping operations. And, it was found that elaboration on the new features of the category emerging from conceptual combination also contributed to production of more creative solutions. Finally, these effects were strongest when people were presented with more, as opposed to less, similar categories.

These findings are noteworthy because they suggest analogical reasoning may underlie successful combination and reorganization efforts. By the same token, however, the [Baughman and Mumford \(1995\)](#) study leaves two questions unanswered. First, does effective execution of these operations, search, mapping, combination, and elaboration, result in production of more creative problem solutions? Second, how do these operations occur when people are presented with more diverse categories? Answers to both these questions have been provided in a study by [Mumford et al. \(1997a\)](#).

In the [Mumford et al. \(1997a\)](#) study, participants, undergraduates, were asked to produce advertising campaigns for a new product, the 3D-holographic television, and solve a public policy problem, a recycling problem, both calling for creative thought. Judges appraised problem solutions for quality and originality. Prior to preparing their problem solutions, however, participants were presented with a set of category combination problems drawn from [Mobley et al. \(1992\)](#) where the quality and originality of the new category labels, new features, and category exemplars were appraised. In addition, category similarity was manipulated under conditions where people were, and were not, asked to think about metaphors – global concepts allowing similarities to be identified in feature search and mapping.

The findings obtained in this study indicated that category labels, features of the new category, and new category exemplars were strongly, positively, related ($r = 0.45$) to the quality and originality of the solutions provided to both creative problems. Thus, there is reason to suspect that feature search and mapping operations of analogical reasoning do contribute to creative problem-solving. Moreover, when people are presented with more diverse categories, instructions to think about metaphors contributed to better conceptual combination and thus better creative problem solutions.

In a third study along these lines, [Scott et al. \(2005\)](#) asked undergraduates to formulate plans for leading a new experimental secondary school. Judges appraised the quality, originality, and elegance of participant solutions to this problem. Prior to starting work on this problem, participants were presented with either concepts derived from prior research on cooperative learning

techniques or actual cases where cooperative learning techniques had been deployed. Moreover, the number of concepts presented (10 vs 20) and the number of cases presented (2 vs 4) was manipulated. As people worked through the concepts presented they were instructed to identify critical features, list feature similarity and differences, combine features, and elaborate on new emergent features. Written answers to the probe questions associated with these instructions were appraised by judges for quality.

It was found the quality with which people executed the search, mapping, and combination, and elaboration operations was strongly, positively, related ($r = 0.45$) to the quality, originality, and elegance of solutions to this creative problem. And, moreover, these relationships became more powerful when people were asked to work with a larger number of concepts in creative problem-solving. Thus the analogical feature search and mapping operations in conceptual combination do apparently, contribute, and contribute strongly, to the production of creative problem solutions.

The Scott et al. (2005) study, however, also provided instructional primes when participants were asked to work with case-based knowledge in conceptual combination. Here, participants were asked to identify the key characteristics of each case, list the strengths and weaknesses of each case, combine the strengths of each case to create a new case model, and forecast the implications of actions given this model. The first finding here was that the most original, highest quality, and most elegant solutions emerged when people worked with fewer rather than more cases in conceptual combination. This finding was not especially surprising, however, because the complexity of case-based knowledge structures makes it difficult for people to work with a large number of cases in feature search and mapping. More centrally, however, the nature of the feature search and mapping operations differed. When case-based knowledge was employed in conceptual combination, feature search and mapping operations became pragmatic, action centered, mappings focusing on attributes of the case leading to success and forecasting the likely success of alternative actions when elaborating the new case model.

These observations are noteworthy for three reasons. First, analogical reasoning mechanisms appear to condition the success of conceptual combination efforts and thus the success of subsequent creative problem-solving efforts. Second, the specific cognitive operations occurring in analogical reasoning differ as a result of the basic nature of the knowledge being used in conceptual combination. Third, use of different knowledge structures in conceptual combination allows people to work with more, or less, distinct types of knowledge.

Search and Mapping

Nonetheless, our foregoing observations suggest that regardless of the type of knowledge under consideration, analogies that promote feature search and mapping, and elaboration on emergent features, provide the basis for conceptual combination and thus impact the success of peoples creative problem-solving efforts. This observation, in turn, breaches three new questions. First, how are key features identified? Second, how are these features mapped to appraise similarity and differences? Third, how does elaboration on emergent, new, features occur? Answers to all three of these questions appear to depend on the nature of the knowledge the person is working with in creative problem-solving.

The identification of key features when people are using case-based, or experiential, knowledge can be traced to the fundamentally pragmatic, action oriented, nature of case-based knowledge. More specifically, elements of case-based knowledge structures held to determine the attainment of significant affordances, good or bad outcomes, are likely to be viewed as key features of any problem solution. Greater weight, however, may be given to actions associated with positive as opposed to negative outcomes. In this pragmatic framing, moreover, constraints that act to limit actions are likely to be perceived as significant features of the problem.

When schematic, or conceptual, knowledge is employed in problem-solving, significant features are most likely to be identified using the general mental model people employ for understanding problems in a given domain. The mapping of features when schematic knowledge is in use will typically be based on integrating concepts relevant to the problem into an overarching model. At times the number and diversity of the concepts involved may make such integrative thinking difficult. Under these conditions, people may employ metaphors to help in concept mapping.

When mapping occurs using case-based knowledge, however, a rather different method will be employed. Strange and Mumford (2005) have shown creative problem solutions are often tied to plans. And, when case-based knowledge is employed, idealized, or prescriptive, plans may provide the key framework used in concept mapping. Often this will require not only identifying key causes and goals appearing in all cases, but also identifying the constraints that might allow these causes and goals to operate in one setting, or case, as opposed to another setting or case (Medeiros et al., 2014). Thus constraints on actions may prove especially important in mapping features when case-based knowledge is used in conceptual combination.

When case-based knowledge is being used in conceptual combination we have a reasonably sound understanding of how elaboration occurs. More specifically, elaboration appears to depend on extensive forecasting when case-based knowledge is employed in conceptual combination. In fact, a study by McIntosh, Mulhearn, and underscores this point indicating that more extensive forecasting is strongly positively related ($r = 0.40$) to idea generation – a key outcome of conceptual combination.

When conceptual knowledge is employed, elaboration appears to proceed using somewhat different mechanisms. One key mechanism is extension of new emergent features to incorporate new exemplars and differentiate this emergent feature from other relevant features. Another key mechanism underlying effective elaboration, when conceptual knowledge is in use, may be found in embedding a new emergent feature in extant mental models – linking this feature to other causes, mediators, moderators, or outcomes embedded in the mental model people use to understand problems arising in a certain domain.

Conclusions

Our foregoing observations with regard to search, mapping, and elaboration operations of analogical reasoning are noteworthy because they provide some important clues about how we might seek to develop people's capabilities for effective execution of the conceptual combination process. For example, one might encourage people to think about metaphors when working with diverse concepts. One might ask people to forecast extensively and carefully evaluate the implications of their forecasts. One might ask people to think about how emergent new features could act as a cause in different models for understanding problems arising in a domain. These, and other potential interventions arising from understanding how analogical thinking occurs in conceptual combination point to a noteworthy, broader, conclusion. Understanding the key operations contributing to effective execution of creative thinking processes provides the basis for formulating a number of new approaches for the development of creative capacity.

The present effort by demonstrating how analogical thinking, search, mapping, and elaboration operations, contribute to conceptual combination provides an illustration of this point. The present effort, however, also serves to remind us that the specific operations occurring in process execution depend on the type of knowledge people are working with in process execution. Hopefully, the present effort will provide an impetus for future work intended to specify how the nature of the knowledge people are working with in process execution shapes the operations required for effective execution of various creative thinking processes.

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Ancient World Conceptualizations of Creativity

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Human Beings: The Creative Species

Anthropological studies show that human beings have displayed creativity from the earliest times. Prehistoric decorative creativity included paintings and drawings, carvings, engravings and sculptures, involved media such as rock surfaces, stone, clay, or bone, encompassed products such as, decorations, figurines, jewelry, or even musical instruments, and consisted of both immobile (e.g., wall decorations) and portable (e.g., figurines, jewelry) works. However, prehistoric creativity was not confined to aesthetic products such as those just listed, but also involved novel tools and life-preserving or life-enhancing daily-use objects such as hunting spears, hand-held scrapers for treating hides, axes, agricultural machinery, water control systems, sewn clothing, and purpose-built dwellings. Such non-artistic products are often referred to as involving innovation, but they will be treated in this entry as examples of what I call 'functional' creativity (Cropley and Cropley, 2005, p. 169). In fact, creativity has been of such core importance from the earliest times that, in the words of Puccio (2017, p. 331): 'The survival and expansion of the human species is fundamentally a story of creativity.'

Terminology

Because the term 'creativity' only began to be used in the English language in the modern sense in about 1875 and there is still disagreement concerning its exact definition, the concept will be understood in this entry in a broad way. The focus will be on the generation of novelty that is in some way useful. Furthermore, useful novelty will be treated as encompassing a wide range of activities and fields, both aesthetic (fine art, music, literature and the like) and functional (e.g., science, engineering or commerce). Rudimentary psychological analyses of what is now called creativity have survived since at least around 3500 BCE (i.e., from the emergence of writing), and have left insights into how it was conceptualized in the distant past. Consequently, the period from about 5000 to about 2000 years ago will define the term 'ancient' for the purposes of this entry.¹

The Purpose of the Entry

The purpose of this entry is not to provide lists of the creative achievements of ancient civilizations, to determine exactly where and when specific creative products first came into use, or to evaluate the precise contributions made by early creative individuals. The entry is also not concerned with what factors in a society – such as the availability and nature of role models, the form of government, or the level of social and political stability – caused, shaped or facilitated/blocked generation of useful novelty in ancient societies. The key issue is how the societies conceptualized creativity and what purpose it was seen as fulfilling. For example,

- How did ancient societies regard creative products?
- How did they understand the process of generation of such products?
- How did they regard people who generated them?
- What was the nature of the environmental press acting on creative individuals?

This structure of the conceptualization of creativity is similar to the 4 Ps framework (e.g., Rhodes, 1961) that is widely accepted nowadays, and covers understanding of Product, Process, Person, and Press.

¹All dates given in this paper, including those in later sections, are rounded and approximate in the extreme. They are not given in order to locate events in exact historical terms, but merely to allow readers to orient themselves temporally.

Case Studies

As [Simonton \(2018\)](#) pointed out, the only way to gain the necessary insights into ancient creativity is to examine what went on in the societies in question. Consequently, brief case studies of four ancient civilizations in the Middle East, the Far East and Europe – Egypt, Mesopotamia, China, and Greece – will be used to cast light on issues such as motivation for the generation of novelty or the social pressures affecting creative people in those societies. These particular civilizations were not chosen by means of random sampling or on the basis of formal selection criteria (for example, that they have demonstrably had the greatest influence on modern thinking), but on the subjective basis that they represent a broad sample of ancient civilizations in which creativity played an obvious role and that a degree of knowledge about how creativity was conceptualized in these societies has survived. The conclusions drawn here are speculative interpretations only, and no claim is made concerning their replicability. The case studies represent extreme simplifications and generalizations about complex societies, so that the risk of stereotyping must be kept in mind.

Egypt (Focus: From Around 3000 BCE)

Music and performing arts, fine art, literature, but also clothing, jewelry, furniture, and architecture were all fields in which the Ancient Egyptians displayed aesthetic creativity. The reign about 3500 years ago of Hatshepsut (1478 BCE–1458 BCE), one of a very small number of female pharaohs, marked one highpoint of such creativity in Egypt: Her mortuary temple was ‘a showcase for creativity’ ([Galán, 2014](#), p. xi). In the case of functional creativity, the Egyptians invented new kinds of construction machinery and developed maritime technology. In manufacturing they developed new systems of mass production, for example for the production of pottery. In science they developed new knowledge in astronomy, mathematics, and medicine.

One striking aspect of Ancient Egyptian generation of novelty is the way the Egyptians understood the purpose of creativity: this was ‘cultural perpetuation’ ([Dorman, 2014](#), p. 1), not only in this world, but also in the next. The key concern of the society was preservation of the traditional way, and excessive novelty was regarded as a potential threat to eternal survival. Although the Egyptians linked aesthetic creativity to the gods, the works it led to were not seen as messages from the gods to human beings but, on the contrary, often contained instructions from humans to the gods, for example advising the deities what humans wanted in the afterlife. Creativity was thus a risky business, as it could send conflicting signals that might confuse the gods and have negative consequences for the rest of eternity. Thus, even in the aesthetic domain creative products in ancient Egypt had a clear utilitarian purpose and obeyed the ‘usefulness imperative,’ which [D.H. Cropley and Cropley \(2015, p. 21\)](#) see as an indispensable property of modern engineering or commercial creativity. Ancient Egyptian creativity was ‘demand-side’ creativity – those on the receiving end dictated what purpose creativity had, what kind of novelty was to be generated, at least in broad terms, and how novel it was permitted to be, and the generators of effective novelty worked within that framework.

The creative process was understood as skilled repetition of known procedures in order to polish – not fundamentally alter or replace – what already existed, and the quality of creative works was mainly determined by their level of artisanship. The Ancient Egyptians sought inspiration from the past, and the source of ideas was mainly existing knowledge and custom. Nonetheless, individual experimentation did occur. However, in generating novelty it was essential to respect socially-imposed limits and change was limited to ‘gradual evolution’ ([Galán, 2014](#), p. x); it was incremental rather than disruptive, involving adding or modifying details, to be sure, but without changing basic forms. Aesthetic works were often carried out by teams, in which individual members were usually responsible for particular highly specific elements of every different work, over and over again. Thus, creative works were not normally attributed to a single extraordinary individual, although contemporary writings did not ignore the idea of personal creativity entirely. For example, [Spiegelberg \(1902\)](#) cites a tomb inscription which says of Meryra, the artist who decorated the tomb in question 3500 years ago: ‘He is not a draftsman; it is his own intelligence that must direct him.’ However, many aesthetically creative products were not intended for public consumption at all, as they were located in the tombs of the people who commissioned them, and the tombs were hidden away. Thus, creative superstars were largely non-existent, and the role of the imagination of the individual creative person was of limited interest.

Mesopotamia (Focus: From Around 3000 BCE)

The term ‘Mesopotamia’ is used here to refer to the region between the Tigris and Euphrates Rivers in the Middle East – more or less the area now known as Iraq. The discussion of creativity which follows encompasses successive dominant cultures in this region, especially Sumeria, Akkadia, Babylonia, and Assyria which, despite their differences, in the period from around 3000 BCE to about 500 BCE demonstrated a number of relatively homogeneous characteristics vis a vis creativity. Mesopotamian functional creativity led to the emergence of writing, which made possible the systematic recording of experience, for example in the form of detailed medical textbooks and new understandings in mathematics, science, astronomy and geometry, as well as codified law (Codes of Hammurabi). Mesopotamian physicians were aware of the importance of cleanliness and personal hygiene, and town planners incorporated this knowledge into the development of clean cities. In architecture and building technology architects and engineers invented the arch and the vault, metallurgists developed novel methods for alloying metals, carpenters developed new tools for woodworking and perfumers and potters developed industrial production processes such as the use of the potter’s wheel, which later led to wheeled vehicles. In agriculture, the Mesopotamians developed novel farming practices such as crop rotation and irrigation.

Aesthetic creativity included poetry, epic stories, fables, proverbs and songs. The recent invention of writing meant that the knowledge and wisdom of the past could be preserved in libraries to ensure that they could be read and consulted by successive generations. Unlike the other ancient cultures discussed above, Mesopotamian aesthetic creativity made a clear distinction between providing representations of what already existed – later regarded by the Ancient Greeks as imitating – and inventing something new: Where events, actions, processes or scenes from the real or mythological past were depicted, not just the technique of presentation but also the actual contents were frequently consciously and deliberately embellished or improved, while preserving the main message. Thus, the idea of artistic license emerged.

The Epic of Gilgamesh offers a striking example: Gilgamesh was an ancient king who ruled in Mesopotamia about 2800–2500 BCE. He first became a legend about 500 years after his death, initially in a number of Sumerian tales, of which five survive. A further 500 or more years later these tales were brought together in a single work by a single, identifiable Babylonian author, Šin-lēqi-unninni, who is regarded by some modern authorities as the creator of epic poetry. Although ancient Mesopotamian literature was largely anonymous, with only a very few well known authors, an intelligentsia emerged whose members clearly differed from mere copyists because they consciously embellished existing contents or invented additional content for literary works, rather than simply copying what already existed, i.e., they practiced artistic license. Such novel representations of events were understood to have their origins in the imagination of these creative individuals, and there was interest in the cognitive processes leading to the generation of fiction.

China (Focus: From Around 500 BCE)

Ancient Chinese functional creativity is commonly regarded as encapsulated in four great advances in science and technology: the compass, gunpowder, papermaking, and printing. One important aspect of these creative advances is that the Chinese went to great lengths to prevent novel technology from passing into foreign hands, although they were ultimately unsuccessful in this. Thus, the Ancient Chinese had an understanding of the commercial value of useful novelty in an international context, as distinct from its internal value in preserving their present, communicating with the gods, or preparing for the afterlife. However, gunpowder and the other discoveries and inventions mentioned above were developed very late in the period on which this entry focuses. Of greater relevance are more ancient examples of Chinese functional creativity in, for example, nutrition (e.g., the fermenting of alcohol and the brewing of tea), clothmaking (e.g., the cultivation and processing of silk), medicine (e.g., the development of acupuncture), metallurgy (e.g., the smelting of iron and the casting of bronze), or agricultural engineering (e.g., the invention of the seed drill).

In the case of aesthetic creativity, in the pre-Confucian era (before about 350 BCE) artworks were produced by anonymous artisans to satisfy the purposes of authoritarian feudal rulers. Creative ideas were shaped by the dictates and desires of the people in power at the time, so that the Ancient Chinese conceptualization of creativity was controlled by the ‘cultural climate’ (Staats, 2011, p. 45) and was largely limited to incremental innovation. At the very end of the period, the upper-class literati began producing music, calligraphy, poetry and painting on their own initiative, and such works became a sign of personal cultivation and education and an indication of individual powers of imagination and sensitivity. Thus, two conceptualizations of creativity existed side by side: the one encompassing the large body of work of the many nameless professional artisans who produced novelty at the behest of those in power (i.e., demand-side creativity), which was ‘almost exclusively imitating’ (Gabora and Tseng, 2017, p. 465), and the other focused on the small body of work of the cultured upper-class elites, who produced whatever pleased them (i.e., supply-side creativity, which was ‘almost exclusively inventing’). The former was seen as mere artisanship and was attributed to manual skill, not imagination; in the words of Edison (Josephson, 1959, p. 97), to perspiration rather than inspiration. The latter was attributed to the creative mind of its makers, and was a sign of cultural superiority, i.e., elitist. This two-track view of Chinese creativity has persisted until today, with many modern discussions focusing on supply-side creativity and the works of revered individuals, rather than on the far more extensive oeuvre of the usually anonymous producers of demand-side creativity.

Ancient Chinese aesthetic creativity initially depicted submission to higher powers – to the forces of nature and the will of heaven – but later began to express increasing understanding of the dictates of these powers and to promote proper moral and social values such as benevolence, virtue, loyalty, fidelity, or purity. Art and literature were thus expected to be beautiful, to be sure, but also to be edifying and socially instructive, i.e., not merely to depict the world but to show people what it ought to be like in an idealized form. Toward the end of the ancient era, the ideals of Confucianism greatly strengthened the ethically instructive role of creativity. Paradoxically, Confucianism is now seen as inhibiting creativity in modern Chinese culture, because of its emphasis on, for example, strict gender roles, rote memory and avoidance of uncertainty.

Greece (Focus: From Around 500 BCE)

Whereas in older civilizations artisanship was regarded as at the heart of creativity, in Ancient Greece making things through manual effort was a sign of inferior status. For example, although the Greek Phidias is still regarded today as a great sculptor, in Ancient Greece he was looked down upon, because he worked with his hands. This contempt for physical labor devalued functional creativity. Nonetheless, the Ancient Greek civilization provided many inventions and discoveries in applied fields, including for example mechanical engineering (e.g., gears, cranes and winches, the steam engine), hydraulic engineering (e.g., aqueducts,

storm-water drains, effective sewage systems), medicine (e.g., a variety of surgical instruments, methods for stopping bleeding and cleaning wounds), and daily-use objects (e.g., the alarm clock).

In the case of aesthetic creativity, in Ancient Greece visual artists were regarded as no more than skilled imitators of the real world, because they merely produced images of what already existed. Only poets were regarded as generating genuine novelty by writing about unseen or imaginary people or events and lofty feelings (such as Olympian rage or devastating sorrow). Thus, the Greeks differentiated sharply between people whose works were judged to be mainly imitating and those whose works involved mainly inventing. The core of creativity was not artisanship but novel ideas. Thus, in contrast to other ancient civilizations, the Ancient Greek conceptualization of creativity gave great prominence to individual people. Although there is doubt about whether Homer was a single writer or a legendary composite figure, names from the classical Greek period around 800 to 200 BCE, such as Aeschylus, Euripides and Sophocles (drama), Phidias (sculpture and architecture), as well as Hippocrates (medicine), Archimedes (engineering), or Pythagoras (mathematics) are even today almost household words. However, the motivation for creativity was regarded as lying outside the mind of the creative individual and reflecting the will of higher powers. Plato and Aristotle concluded that the chosen ones were forced to carry out their creative work whenever the divine powers acted on them because they were in the grip of what Plato called a 'divine frenzy' and Aristotle a 'tincture of madness.'

This conceptualization made creative individuals a breed apart from mere mortals, since they were messengers of the gods. In turn, this had important positive consequences for their social standing: they were prominent, highly admired figures in their society. Their celebrated creativity yielded handsome personal rewards, giving them what Deresiewicz (2015) called a 'sacred aura,' and entitling them to the benefits of a 'sacerdotal tax' (i.e., they enjoyed almost priestly status and were entitled to have their way of life financed by the general public). Thus, creativity came to be linked with chosen favorites of higher powers who developed unprecedentedly new ideas through personal inspirations granted to special individuals, not by preserving and skillfully expressing what already existed. (This veneration of creative superstars continued into Ancient Rome. For example, Horace (2005) (c.19 BCE, lines 9–10) pointed out that in Rome artists enjoyed special licence to do as they pleased.) Thus, Ancient Greek creativity was supply-side creativity with great emphasis on the idiosyncratic, god-given inspirations of revered talents.

Analytic Overview

The conceptualizations of creativity in the four ancient civilizations can be compared and contrasted in terms of broad themes, which can be summarized in terms of the well-known 4 Ps of creativity: Press (the social function of creativity), Product (the preferred kind of novelty), Person (the perceived role of the individual), and Process (embellishing what already exists vs. replacing it). The purpose of such a summary is not to provide an exact analysis of several thousand years of history in four different civilizations, but to use dimensions derived from the modern understanding of the psychology of creativity in order to give a broad idea of where similarities and differences between civilizations lay.

The conceptualizations of creativity in the ancient civilizations share common broad dimensions such as the idea that creativity has a role in the divine order of things. However, these do not form a homogeneous set of ideas that prevailed in more or less identical form across the ages and across cultures. For example, the Egyptians regarded aesthetic creativity as a way for humans to send messages to the gods, whereas the Greeks saw it as a way of receiving messages from the gods. The Egyptian society would not tolerate any fundamental change in the way human existence was depicted, as this would have threatened their eternal life by sending mixed messages to the gods, but accepted only technical embellishments to the presentation of this understanding (i.e., the message had to be always the same, although it could be presented more clearly or packaged more attractively). By contrast, the Mesopotamian society understood the need to change the fundamentals in order to achieve improved effects (poetic license), and the Greeks specifically demanded serious departure from the usual; otherwise products were no more than imitations.

Nonetheless, there seems to have been a discernable sequential change in the conceptualization of the Person from the almost completely anonymous artisan of the Egyptian civilization to the favorite of the gods of the Greek, with the rise of what I have called the "creativity superstar" emerging in stages, rather than all at once. In the case of understanding of Process, there seems to have been a similar step-by-step change in the acceptance of modification of already existing ideas, from the point where it was absolutely forbidden (Egypt) to the point where, in the Ancient Greek civilization, it was absolutely required. There appear to have been similar systematic developments in connection with Press (from social rejection of change to insistence on it), and with Product (a movement from skilled imitation of existing forms to creation of new forms). Experimental studies (e.g., Gabora and Tseng, 2017, p. 465), suggest that particular social conditions promote 'almost exclusively imitating,' whereas other conditions promote 'almost exclusively inventing.' Cross-cultural studies of the repercussions of increasing societal complexity demonstrate these effects in actual life, with artisans emerging long before artists.

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Animal Creativity

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Introduction

In humans, creativity is used for communication, expression, pleasure, courtship, problem-solving, and countless other activities. Some are of great urgency, whereas most are not. In the animal world, however, creativity is often literally a matter of life or death. Imagine a cane toad happily eating bugs and small creatures in the wilds of South America. One day, it is captured and flown off to Australia. When the toad hops out of its cage in a new country, it finds none of the bugs from South America with which it is familiar. Will the toad starve? This is where creativity comes in.

Evolution is commonly referred to as survival of the fittest. But it's really not. Evolution is survival of the most well adapted to the situation. While that works less well as a tag line, it describes the situation far more accurately. Change is constant in the outside world. An animal who can't get along despite the change – moreover, an animal that cannot use change to its advantage – will likely not survive. As [Runco \(2014\)](#) noted, adaptability is a key component of many theories of creativity. Animals may not paint or dance, but they absolutely create and innovate.

Examples of Animal Creativity

Invasive predators such as the cane toad in Australia are spectacular examples of how creativity and innovation can serve to keep animals alive. A toad in an unfamiliar environment must be creative to fulfill its need for food. It must find something to eat which is both novel (i.e. has never been seen before, because this is a new environment), and appropriate (a sufficient source of sustenance). The stakes are never higher – the lack of use of a novel food source means starving because the toad does not recognize any of the bugs. An inability to find an appropriate food source means attempting to get nutrients from chewing on old shoes.

The cane toad, as it happened, was particularly good at finding new food sources – namely, anything it could fit in its mouth. The toad, originally brought in for pest control, has now become an overpopulated pest in Australia itself.

Although it may sound slightly silly, examples such as these play out all the time in the natural world. Has the forest that housed your tree nest burned down? Did a drought cause your watering hole to dry up? Time to innovate. An appropriately creative animal may enhance its ability to find food, remain healthy, or produce more offspring. For example, the dolphins of Shark Bay, Australia, have adopted a habit of covering their rostrums (the “snout”) with a soft sponge while foraging. These animals forage by stirring up the dirt and sediment from the ocean floor, and the sponges protect them from cuts and abrasions from, for example, coral. In the wild, an infection of a cut or abrasion can be deadly ([Krutzen et al., 2005](#)).

There are many other noted examples of creativity in the animal kingdom. Consider the bowerbirds of Australia, a species in which males build elaborate bowers and “dance” in front of them to court females. Bright, shiny objects are valued and males who decorate their bowers with them tend to be more successful in their courtship attempts ([Borgia, 1985](#)). There is extensive tool use in primates such as chimpanzees who have learned to probe termite hills with a stick for a meal, or capuchins who use rocks as hammer and anvil to break open hard shelled nuts. In some of these cases, younger group members have been known to identify the best innovators and tool users and spend more time observing them than other members of the group ([Ottoni et al., 2005](#)).

Specific examples of animal creativity abound. There is the case of the subordinate chimpanzee who learned to bang together trash can lids to frighten other members of the troop, and thus moved up in the hierarchy and gained access to mating opportunities ([Goodall and van Lawick, 1971](#)). There is also Imo, a Japanese Macaque who discovered water could be both used to remove sand from her food before eating it, and to separate rice from dirt ([Kawai, 1965](#)).

In all these cases, individuals of a species have innovated an object or behavior which has significantly improved either their ability to gain food or access to mates. Because these innovative individuals have survival and mating advantages, they tend to produce more offspring – which in turn share the increased innovative abilities of their parents. Although it is difficult to study, there are basic characteristics and abilities which animals do show which can be used as a proxy for judging innovative ability. [Kaufman and Kaufman \(2004\)](#) (see [Kaufman et al., 2011](#)) has proposed a three-level model of animal innovation.

At the first level, an animal which innovates must be at least a little neophilic (attracted to novelty). Most of the time in the animal world, neophobia is the default – if it's new, stay away! New things could be harmful and the risk is rarely worth it. However, the cane toad which never approaches the weird-looking new bug is certainly going to starve. The trait Openness to Experience has been generalized to this in animals – often called boldness. And, like humans, animals show consistent and distinct variation both between species and within individuals of the same species – this is often referred to as “individual differences,” as opposed to the human term “personality.” A second trait associated with increased creativity and which varies across individuals within a species is behavioral plasticity (Carter et al., 2012; Chamove et al., 1972; Dingemanse et al., 2005). Behavioral plasticity is the amount of change which can occur within a standard behavior repertoire. Individuals with higher behavioral plasticity are able to nest on the top of a telephone pole when the trees are gone or slurp the remaining liquid out of discarded water bottles when the watering hole dries up.

Second, although not necessarily required for creative activity, very often creative animals are good at observational learning. There are many examples of well-known animals who have developed new and creative techniques (often associated with foraging for food), which have promptly spread throughout a population by observation and become standard behaviors (Ottoni et al., 2005; Povinelli et al., 1996). A cane toad watching its cane toad friend eat a bug, will not have its ability to survive impacted by whether it pauses to watch what happens to its friend. However, seeing and being able to imitate the behavior if it produces a desirable outcome, will certainly be a big help.

Several other common creativity theories can also be helpful to tease out how animals can be creative. The 4P's – Person, Product, Process, and Press (Rhodes, 1962) – each have animal analogs. The creative product is perhaps the most obvious way to examine creativity – in the examples above, this might result in a beautifully elaborate bower or a tool which works particularly well to crack open nuts. Likewise, the press or environment in which the creativity occurs is extremely important, albeit in a very different way from how the creative press is discussed among humans, as the beginnings of this chapter allude to. Often, creativity is necessitated by the status of the environment – or rather something which changes in that status. Available resources become key – a bird which might have the potential to build a nest on a telephone pole instead of a tree is unable to use that creative ability without nest making material being readily available. Groupings of animals within animals (called conspecifics) can impact innovation rates, although the research has yet to show any clear trends on the specifics. Studies of groups of animals have shown significant variation in innovation with group size and composition, but additional variables make the case less clear than a simple increase or decrease.

It is difficult to examine the creative process in animals; it is difficult to even make conclusions about the intentionality about many of the acts described earlier. It may be hard for people describe how or why they create, but we are at least, able to ask questions – a luxury we do not have with animals. Even planning is difficult to measure in animals, and there is little consensus on the extent or which it occurs or how that might be determined (Clayton et al., 2008; Correia et al., 2007; Suddendorf and Corballis, 2008). In one example, in order to obtain a reward a crow needed a tool of a certain length. However, that tool could only be obtained by using a second tool, which itself could only be obtained by using a third tool. And so forth. At least one member of the species has been reported to have been successful at the task and to have accomplished it in a purposeful manner. In other words, it obtained the tools in the correct order with little hesitation, as opposed landing on the correct pattern in which the tools needed to be used by random trial and error. Although this does appear to be evidence for planning and innovative use of the tools, it provides only a small amount of insight into the animal's actual planning and cognitive abilities as the inherent problem of lack of expression of the thought process remains (Wimpenny et al., 2009).

Finally, the creative person can provide an interesting way to examine creativity in animals. Often the creative person is modeled based on the 4Cs. The 4 C model frames creativity as mini-c, little-c, Pro-C, and Big-C (Kaufman and Beghetto, 2009). Mini-c is creativity which is personal and meaningful to an individual. Most animals innovating for food, play, social position, reproductive success, or exploration are creative at the mini-c level. Their creativity is “personal” and meaningful only to them – for example, a tool used to obtain food or a pretty flower used to decorate a nest. But innovations which spread among populations via observational learning begin to show characteristics similar to what creativity researchers call Pro-c, or professional level creativity. Consider for this level the cane toad mentioned above who tries the new bug. In some cases, particular animals actually gain a reputation for innovative abilities, or groups of animals learn to watch the group members who are most proficient at particular tasks.

The male bowerbird mentioned above is a different type of creative “person”; one for whom often times innovation can be useful in the competition for mates – i.e. sexual selection. His creativity is little-c; it's meaningful to more than just himself because it effects the other males nearby and the females being courted (Borgia, 1985). The bowers which male birds of this species build are not just elaborate nests, but are garnished with all sorts of objects the birds search out. Female birds (and thus the males courting them) prefer shiny, colorful, and novel objects. In some species, there is even a favorite color. After the bower is decorated, the male stands outside it and dances to invite the female in. Whether the female chooses him and enters his bower to mate appears to be directly correlated to the quality of his bower. It's as if the male is advertising that he has strong genes and good foraging skills – he has plenty to eat so he has time to look for decorations, and he is crafty enough to be able to location preferred objects. It's vaguely reminiscent of a poet with enough time and ability to produce sonnets for a potential beau. It is harder to determine if there are Big-C “genius” creators; however, there are certainly animals whose creativity continues to be remembered after their death, such as the African Grey parrot Alex who pioneered research in avian intelligence and showed us parrots had complex cognitive skills, could use language in purposeful ways, and were able to develop basic numerical skills (Pepperberg, 2012).

Lastly, and perhaps most intriguingly, some animals have enough cognitive abilities that they can be trained to innovate. “Innovate” or “Do something new” is a common behavior trained by zoos, aquariums, and training hobbyists in which animals can be asked to do an original behavior (Pryor et al., 1969). This can be as basic as the animal touching its nose to a ball and then to the

couch (a different object), or can, in some cases, result in triple back flips. Similar to how creativity can be measured using the Torrance Tests of Creative Thinking, it seems that the abilities of animals who know how to innovate in this situation can be measured by examining the fluency (number of behaviors an animal is capable of innovating), flexibility (whether the animal touches it's nose to different objects or shows more categorical variety), elaboration and originality (Kaufman and Kaufman, 2019). Many people are surprised by the creativity which animals can display here, as alluded to earlier, animals aren't something which might automatically come to mind about creativity. However, not only is it an excellent way of demonstrating those creative abilities, it is something that many pets and their owners do together for enrichment and to build relationships (Pryor, 1999).

Conclusion

Creativity in animals, much like creativity in humans, manifests itself in many different ways. Your dog might paint you a picture, but most likely he did it by walking through paint and then across canvas; not intentionally creating art. Nevertheless, your dog (and other animals) can be creative. These abilities may not serve to express emotion, communicate, or even consciously create new ideas as is typical of creativity in humans. However, whether through helping to adapt and avoid threats, find mates, or obtain food, they are vital to the survival of both individuals and entire species as environments and conditions change. From seeking out novelty or picking up new behaviors by observing peers to tool use or innovating in response to encouragement to actively problem solving and discovering new solutions, animal creativity can be small steps or giant leaps. Given the inherent difficulty of studying the topic, there is an impressive breadth and range of information available.

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Glossary

Bauhaus ('House of building' in German) Name of an avant garde design, crafts and fine arts school, founded in Germany in 1919 by Walter Gropius. Until its closure in 1933 the school operated in Weimar, then Dessau and finally in Berlin, and had a profound impact on modern architecture, design and art

Beaux Arts Short for Ecole Supérieure des Beaux-Arts ('Higher school of fine arts' in French). The school was founded in Paris in 1648 and became independent in 1863. Beaux Arts schools were established throughout France, the rest of Europe, and later also America. They keyed on classical arts – Greek and Roman architecture, and studying and imitating the Great Masters and the classical orders

CAD/CAAD Computer Aided Design/Computer Aided Architectural Design. Computational tools that support designing with various kinds of software

Deconstructivist architecture A movement within postmodern architecture as of the late 1980s. It is characterized by fragmentation, manipulation of a structure's surface or skin, non-rectilinear shapes that serve to distort and dislocate some of the elements of architecture, such as structure and envelope. The theoretical underpinnings of deconstructivism were largely influenced by the philosophy of Jacques Derrida

Performatism A contemporary interpretation of performance in architecture, embedded in digital design, which aims to incorporate functionalist and image-based approaches to form making and conception

Postmodern architecture A movement and style within the postmodern culture that flourished in the 1970s and 1980s. It came into being largely in reaction against the starkness and uncompromising modernism of the International Style. Postmodern architecture is characterized by the combination of modern forms and materials with a highly conscious use of motifs and conventions from earlier periods including decoration, which was not accepted by the Modern Movement

Self/unselfconscious design Terms coined by Christopher Alexander. A selfconscious process occurs in a culture undergoing rapid changes that bring about random designed forms because designers are unable to respond to change systematically. Unselfconscious design occurs in a stable culture where occasional and slow changes cause only minor adjustments to robust, failsafe designed forms

Starchitect A star architect, who produces exclusive, so called 'signature buildings'

Vkhutemas (Acronym for 'Higher Art and Technical Studios' in Russian) Name of an avant garde art and technical school founded in 1920 in Moscow. It was dissolved in 1930 but was nonetheless responsible for one of the great revolutions in the history of art (constructivism)

Introduction

The history of designing buildings goes back several millennia. It is reasonable to assume that for a long time, huts, and later buildings, mostly of modest size, were made to respond to basic needs of shelter. However, social life, which had taken place primarily in the open, eventually also required accommodation in buildings as well. The first known building of a monumental size that is believed to have been the brainchild of an appointed architect is the Pyramid of Djoser in Egypt, designed by Imhotep between

[☆] *Change History:* April 2019. Gabriela Goldschmidt updated the text throughout the article.

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2630 and 2611 BCE. Until the modern era, the history of architecture is told through mostly large-scale buildings with symbolic significance erected to house religious, government, cultural and social functions. The rulers who commissioned them also had palaces designed and built for themselves, to serve as status symbols as much as living quarters. In modern times other building types emerged that acquired architectural prestige (diverse additional cultural centers, commercial edifices, transportation hubs, educational institutions, and more). Residential buildings, other than houses for the very rich, were not considered worthy of architectural attention until rather late in the modern era.

Outstanding buildings do not spring into being by chance, as arbitrary triumphs of creative architects. Exceptional buildings embody ideas that had ripened within a culture or micro-culture and were translated into built form; in return, exceptional works of architecture often extend such ideas and promote further development of architectural theory. Thus, the history of architecture is largely a history of ideas; both general ones, which define historic styles, and individual ones that are responsible for outstanding buildings.

The two major aspects that guide the design of any building are function and form. Every building must serve the purpose for which it is being built, and it must have a physical form, which impacts upon both its users and those who perceive it from the outside as part of the environment. The evaluation of form and function is well aligned with the two most prominent measures of creativity: originality and practicality. In the behavioral sciences creativity is often measured as the sum of originality (novelty) and practicality (usefulness) of the outcome of a design undertaking. Although design of any kind is considered to be a creative activity, there are of course designs which are more creative than others, and it is these that are most interesting for this chapter. The entry will touch upon ideas in architecture, including the latest developments which are largely contingent on digital design technology. It ends with a section on architectural education which is greatly concerned with questions relating to ideas, form, function, and creativity.

Leading Ideas: Self-conscious Architectural Design

In 'Notes on the synthesis of form' Christopher Alexander, a leading design theorist in the 1960s and throughout the 1980s, distinguished between 'self-conscious design' (Alexander's original term), as practiced in the modern era by professional designers, and 'unself-conscious design', which was practiced by people who conceived buildings and other needed structures mainly before design became a formal professional activity in its own right. Unself-conscious design is responsible, well into the modern era, for what is referred to as traditional, vernacular or indigenous architecture, and is highly localized.

In 'The appearance of the form' John Habraken recounted how, in the twentieth century, a house was built for a priest in a small Dutch village. The carpenter who was charged with constructing it received the following instruction: "... the priest needed, unlike other folk, a room to study and receive visitors." This was all the information he needed; as for the rest, the carpenter had a very precise mental model of a house in that community, to which he merely had to add the extra room. The mental model addresses the 'style' of the building as well as all other design issues: the size, the room layout, building materials, and so on. In vernacular architecture buildings of the same type resemble each other; examples of the past are followed, and there is no drive to change anything unless it is absolutely necessary. The beauty of such architecture comes from its perfect adaptation to its surroundings and its function, as was cogently shown by Bernard Rudofsky in the MoMA exhibition and catalog 'Architecture without architects.'

In addition to the general cultural context in which it is embedded, more recent self-conscious design must also be understood in light of a narrower micro-culture to which a designer subscribes. Tradition is no longer enough of a moderating factor, and several approaches or design styles may be concurrently acceptable. Designers seek to belong to professional communities and to that end they subscribe to a micro-culture that best accommodates their values, beliefs and taste. This is a dynamic state, of course: cultures and micro-cultures do not stand still, nor necessarily do one's affiliations. Both traditional cultures and contemporary micro-cultures constrain design in terms of shapes, forms, patterns and their combinations. There are explicit and implicit rules that designers are expected to follow regarding the spatial world within which they play out their designs. 'Playing by the rules' is in fact one's ticket to membership in a particular micro culture, or design style. However, the most creative architects are known for their breakthroughs in which the rules are, at least, extended.

Striving for Novelty and Leading Ideas

Contemporary design is highly self-conscious. Architects strive to innovate within the culture or micro-culture to which they belong. To be considered creative architects have to try to push the boundaries of what is acceptable. In other words, they try to distance themselves from the typical in favor of a new and surprising design solution. More often than not, novelty rests on a 'leading idea' which drives the design. A leading idea in architectural design may be related to any one of different aspects of a building: spatial organization, building performance, the forms used to enclose spaces, façade composition, building materials, structural system, and so on.

Self-consciousness in design and the leading ideas that epitomize it are not restricted to contemporary times, of course. The Italian Renaissance architect Filippo Brunelleschi earned his fame mostly by devising a way to build the largest dome of his time, that of the Duomo of Florence, Santa Maria del Fiore. His creative contribution was the structural system of the dome. The contemporary architect Santiago Calatrava also built his reputation on the ingenuity of his structures, many of them bridges. In both cases the structural solutions are responsible for the striking architectural quality of the ensuing buildings. In contrast the

Swiss architect Le Corbusier, considered one of the greatest architects of the twentieth century, designed the residential building *Unité d'Habitation* in Marseille, France (1955), where the innovative feature was the spatial organization of the building. In this twelve-story building, which includes commercial and community facilities along an inner 'street' at mid-height, corridors run every third floor, leading to two-level apartments that span, on one of the levels, the entire width of the building. A very well known example of creative architecture due to novel building forms is the Guggenheim Museum in Bilbao, Spain, by Frank Gehry, completed in 1997, which, like other Gehry buildings, is composed of bold large curvilinear forms. Somewhat less known is the fact that the building also boasts an unusual application of a cladding material – sheets of titanium. A building that owes its fame entirely to the novel building material chosen for its enclosure is the Beinecke Rare Book Library at Yale University, designed in 1963 by Gordon Bunshaft of the firm of Skidmore, Owings, and Merrill. All exterior walls of the building are made of translucent marble, which transmits subdued lighting and provides much needed protection from direct light which would have harmed the rare manuscripts the building houses.

What the above examples have in common is the fact that all of them offered new solutions to at least one major architectural aspect. These architects did not follow precedents and succeeded in making a significant breakthrough by offering an entirely new way of treating that particular aspect. In terms of problem solving, it may be claimed that the novelty of the architectural solutions in these cases stemmed from a conscious breach of the habitual problem space (design space, in this case) in which the architects searched for a solution. Despite their novelty, however, even exceptional works of architecture continue to be embedded in their cultural circumstances and are identified by a style or movement they belong to (which, in extreme cases, they help create). However, contemporary digitally generated designs threaten to be independent of any context other than the technology used for their conception.

Styles and Paradigmatic Shifts

Styles and micro cultures are based on overarching ideas over which there is a consensus within the relevant communities at a given period. Such ideas are encompassed in theories, expressed in writing, often in the form of treatises. The earliest treatise still referred to today is by Vitruvius, a Roman architect and theorist who lived in 1st century BCE. His writings were rediscovered in the Renaissance and have had a lasting impact on architectural thinking and practice. Fil Hearn compiled the most important treatises throughout history and demonstrated the key role they played in shaping important works of architecture. Architectural styles are rooted in shared formal theories and the appearance of each style is accompanied by corresponding treatises.

The twentieth century saw the rise of three major styles: modernism, postmodernism, and deconstructivism. The modern movement was born at the turn of the nineteenth century. It strove to free buildings from formal historic compositional principles and excessive decoration, and to make them more suitable to the new lifestyles of a more egalitarian society that recognized everyone's right to live and work in improved built environments. With the social motivation, formal design principles were also widely accepted, including regularity rather than axial symmetry as an organizing principle, the breaking of large masses into smaller volumes that form three-dimensional compositions, and the removal of decoration in favor of volumetric composition as the main aesthetic appeal of a building. In the 1920s two new design education programs were launched, at the Bauhaus in Germany and the Vkhutemas in Moscow. In both schools the new ideas of modern architecture underpinned the curriculum, in contrast with the prevailing neo-classical approach that was the rule in Beaux Arts schools throughout Europe and North America (for further discussion on this topic please see below the section on Architectural Education).

Following an exhibition at the MoMA in New York in 1932 the ensuing style was dubbed 'International Style', a term advanced by Henry-Russell Hitchcock and Philip Johnson, who were the exhibition curators. Although the style was born in Europe and crossed the ocean to North America, today one of the largest concentrations of International Style buildings (some 4000) is to be found in Tel Aviv, Israel; the area in which they are concentrated is called White City as these buildings are predominantly white. The style was brought there by the many immigrants from Europe who arrived in Palestine in the 1930s and 1940s. In 2003 UNESCO proclaimed The White City of Tel Aviv a World Cultural Heritage site.

Postmodern architecture emerged as part of a wider cultural shift. It was mainly a stylistic tour de force, which rejected the austerity of modernism and embraced, once again, historicist and decorative connotations. Postmodernism was permissive rather than purist. For the first time the envelope of a building no longer had to express the volumes and spaces it enclosed and acquired an independent status of its own. Therefore, the modernist slogan 'form follows function' lost its currency during the postmodern era.

In the late 1980s a further stylistic development within the postmodern culture brought about deconstructive architecture, which was heavily influenced by the writings of the French philosopher Jacques Derrida who coined the term 'deconstruction'. The term refers to the close analysis and breaking up of texts into fragments that are not necessarily seen as co-existing harmoniously. In architecture, deconstructive work is characterized by fragmentation of building volumes to the point of tension among them, non-rectilinear shapes, often with sharp angles, and a dismissal of any formal commitment to building typology, which was important to modernist architects. In architecture deconstructivism is also akin to constructivism, a movement in art and architecture in Russia that was active from 1919 until 1934. The constructivists were part of the modern movement, but had a more radical and innovative approach to the treatment of shape and form.

Architects who pioneered these styles forged and developed the ideas that defined the styles, along with theorists and historians whose writings helped lay the foundation for the movements' theoretical underpinnings. Needless to say, there have always been voices that proclaimed other ideas, away from the mainstream. When postmodernism reigned, a smaller movement called

regionalism advanced different ideas: in opposition to the universalism of postmodernism they preached localism: respect for local culture, building traditions and so on. The deconstructionist era also saw, in parallel, a growing concern for the environment which was finally embodied in a movement for sustainable architecture, now also referred to as 'green architecture', which emphasizes the measurable performance of buildings (but not in opposition to spatial excellence), such as thermal comfort, daylight control, ventilation, energy consumption and even water recycling. At present no major style reigns in architecture (unless digital design is treated as a style; see 'The digital shift' below). This does not preclude new theories from influencing both practice and discourse about architecture. An example is the books by the architect Rem Koolhaas that have had more impact than the buildings he designed.

The Form-Function Dichotomy and Beyond

The dictum 'form follows function' is attributed to Louis Sullivan, a prominent American architect who was active when steel first became a primary building material late in the nineteenth century, used for the construction of building frames. Steel frames, along with the introduction of the elevator, made it possible to build taller buildings and Sullivan is known as a pioneer of skyscrapers design. This building type, completely new at the time, with the new design issues it brought with it, emphasized a renewed interest in functional aspects of architectural design. The turn of the century was a time in which many social and technological changes took place that encouraged a willingness to break away from conventions that had dominated in architectural design until that time. The new attitude was the background to the growth of the modern movement which, not surprisingly, endorsed 'form follows function' to the point of turning it into a slogan. Form and function were always conceived as two complementary but dichotomous parameters that define architecture. This is not to say that form or function are, or can be, mutually exclusive: both are musts in architecture.

During the 1960s a concentrated effort was made to introduce systematic, scientifically-based design methods into architecture. A number of international conferences related to methods were held, most of them in the UK, as part of what came to be known as the 'design methods movement'. Many of the methods in question were adapted from engineering and management, and their goal was to optimize design outcomes by ensuring that all relevant issues would be addressed properly. Two decades later it became clear that despite the efforts invested in design methods, they had failed to have an impact on either practice or education. There was more than one reason for this failure. First, the methods were very laborious and technical, and architects felt that they crippled their creative initiatives. Second, high hopes for automated processes in which computers would play a decisive role were premature and had left designers disappointed: computational technologies were far from capable of delivering the desired results. Third, and possibly the most important reason for the failure of 'methods' was the fact that with the advent of postmodernism, satisfying functional design requirements had lost its priority in favor of articulating form, or more specifically, the independent design of a building's envelope, into which spaces were fitted that accommodated the building's program. Exciting facades became so important that Robert Venturi and Denise Scott Brown, prominent architects and contributors to postmodern architectural discourse, wrote 'Learning from Las Vegas,' in which they talked about the acceptability of even the most simplistic box-like buildings, provided well-designed façades were attached to them like a billboard or very large advertisement. The consequences of this theory are discernible today in places like Times Square in Manhattan.

Today the term 'performance' has replaced function in discourse. The change of term signifies commitment to a higher-level scrutiny of building and environmental requirements, which is made possible with state of the art computational tools.

The Digital Shift

Computers have permeated design as they have pervaded almost every other area of life. The use of computers in design goes back to the 1960s, notably with the landmark system Sketchpad developed by Ivan Sutherland at MIT. By the 1980s CAD (Computer Aided Design) and CAAD (Computer Aided Architectural Design) became established research fields, taught in schools of architecture, and making their way into practice. Early computational tools were seen as supporting design in several ways, from drafting and the creation of fast and lively renderings, to flexible instantiations of designed objects through parametric control over design constraints. Specific programs were written for various building performance aspects, e.g., the determination of window sizes and shading requirements for best climatic performance.

Today's advanced digital design systems have generative capabilities and they are able to create non-Euclidean geometric spaces and transform them in the blink of an eye. Frei Otto designed the roof of the Olympic stadium built for the Munich games in 1972. The structure, considered very innovative for its time, consisted of large sweeping curvilinear canopies. During the design process Otto had to model the forms he was designing manually with elastic fabrics (allegedly he used ladies' stockings), as there was no way to represent their geometry accurately otherwise. Today structures like this are easy to model digitally. Moreover, up to a certain size complex forms can be manufactured with no need for any intermediary representation other than the digital model, which is fed into a CAM (Computer Aided Manufacturing) system. CAD-CAM systems are ubiquitous at high-end industries such as airplane and car production plants.

One of the immediate impacts that these new capabilities have on architecture is the ability to break away from the straight line in favor of an 'emancipated' world of rounded and curvilinear forms. This includes many varieties of spatial expression, some of which are sometimes referred to as "biomorphic." The term suggests a trend to emulate natural forms that, at different scales,

are by and large composed of non-Euclidian, curvilinear shapes and forms. This world of forms had been lost to architecture until now because it was not possible to represent and specify them properly, as in the case of the Munich Stadium. Now that this has become possible, and it is no longer excessively expensive to manufacture irregular building components, architects are at liberty to explore a whole new array of spatial forms, and a growing number of them, especially young architects and students of architecture, are happy to immerse themselves in this new and challenging universe.

Digital design is largely preoccupied with form, but it also advances the designer's ability to model and therefore predict and control the building's performance. Alternative values and tradeoffs can be tried out quickly and inexpensively in order to arrive at an optimal or balanced performance. The centrality of the issue of performance has led to a branch of digital design known as 'performatism'. Performatists stress the need to advance digital design not only in terms of forms and their production, but also in terms of the way they respond to needs, both needs of their own technical systems ('clever buildings') and the needs of the people who inhabit and use them.

The options that digital design opens up are vast and potentially revolutionary. At present we see collaborations between architects and other designers, engineers, materials scientists and computer science specialists, who endeavor to push the boundaries of architecture. Using tools of artificial intelligence, robotics, 3D printing and biological processes, completely new concepts of architectural space are created. An example is the work of Neri Oxman and her associates at MIT's Media Lab. The Silk Pavilion they created in 2013 was a dome the skeleton of which was made of aluminum scaffolding onto which an initial lattice of silk threads was strung by a robot. Then live silkworms were placed on this lattice and over a period of several weeks the worms span their own silk threads until the entire dome became almost entirely opaque. Works of this nature give us a glimpse of future possibilities which, to a large extent, are still difficult to imagine.

How will people relate to complex forms of such different geometries? How will structures relate to one another? Today they are treated rather as discrete objects, whereas there is generally a preference for thinking of buildings within contexts, primarily urban contexts, where continuity and coherence of a broader urban fabric are sought and open urban space is planned to complement buildings with equal heed and prudence. What would such an open space be like if the buildings that abut it were all composed of forms that were convex and curved onto themselves and usually turned a concave and possibly alienating face to what surrounds them? How will people inhabit and furnish curvilinear spaces should they be severely constrained in size, in contrast to vast spaces in current tour de force examples? For example, the Dalian International Conference Center in China designed by Wolf Prix of Coop Himmelb(l)au and inaugurated in 2012, or Zaha Hadid's Dongdaemun Design Plaza in Seoul, completed in 2014. Both these landmark buildings require vast open space around them because they cannot be integrated into a continuous urban fabric.

Most importantly, the new technologies pose questions regarding the very act of design, and the role of the architect. The new digital systems are imbued with intelligence that allows the architect to try different values for the same design parameters and obtain results that often surprise the designer who may receive unexpected outcomes. The future architect will most probably continue to make the decisions, but what decisions? Is he or she to choose from among proposals obtained digitally, adjusting the input so as to come closer to satisfying constraints or requirements? Who will determine the constraints and requirements, or the goals? In other words, conventional artificial intelligence as it is known today will no longer suffice; it may become necessary to talk about a higher digital intelligence, and digital creativity, at least as far as design is concerned. Such intelligence and creativity will have to be pitted against the architect's creativity and intelligence. The old question regarding the nature of the partnership between the designer and the computer in the design process has never been as acute as it is today. It is hard to predict what architecture and architectural practice will be like a few decades from now, but it is certain that the digital shift will have a profound and irreversible impact on built form and its production as they have been known and practiced until the present.

Starchitects and Other Practitioners

Although architectural design, and design in general, are creative activities by definition, not all works of architecture are equally creative, nor are all architects uniform in their creativity. In a paper published in 1962 Donald MacKinnon presented a study of personality correlates of American architects, in which he found that there were significant personality differences between more and less creative architects. Creativity correlated positively with higher levels of affective intelligence, openness to experience, freedom from petty restraints and impoverishing inhibitions, aesthetic sensitivity, cognitive flexibility, independence in thought and action, high level of energy, unquestioning commitment to creative endeavor and unceasing striving for creative solutions to ever more difficult architectural problems.

In a book published in 1998, the sociologist Garry Stevens looked at architectural practice and found it necessary to distinguish between architecture as a field and architecture as a profession. The profession is the more mundane of the two; it represents the business of designing buildings for clients to fulfill defined purposes. In their capacity of architects working in the profession, architects provide design services to clients, be they owners, users, or representatives of public or private organizations. It is a business-oriented activity in which architects try to excel, while being highly client-minded and constrained by the client's directives. Expertise is much valued in the architectural profession, and there are firms that develop special expertise in a particular building type, e.g., hospitals.

The architectural field transcends ordinary practice. It is more concerned with innovation and with a cultural discourse through writings and built form. Architects who operate in the field of architecture are privileged; they see themselves, and others regard them, as practicing at a higher level than other professional architects. They are status oriented and instead of being client-minded

they are eminence-minded. They hope to produce landmarks, rather than buildings that ‘just’ serve their users well. Clients turn to architects of this kind when they are interested in a product that would serve as a status symbol, and are willing to compromise some of their control over the building program and design decisions. They are also willing to pay higher fees, in addition to higher construction costs.

Stevens calls the architects in this group ‘the favored circle’. Those at the top of the list are known to us as ‘starchitects’: they become cultural heroes, even celebrities, and their iconic buildings – ‘signature architecture’ – are included in lists of attractions to be visited by tourists. A well-known case in point is the Guggenheim Museum in Bilbao, Spain, completed in 1997, by Frank Gehry. The building is said to have done wonders for Bilbao, then an industrial city with a decaying economy, by bringing in an average of close to one million tourists each year (about eight times the number before the building was built). The project costs were overwhelming (over 200 million Dollars), but the city gained hundreds of new jobs, hundreds of thousands of overnight stays annually, along with other business that tourism generates.

Starchitects are definitely among the most creative of architects. Their creativity rests primarily on exceptional originality, whereas in terms of practicality they do not necessarily achieve better results than other good architects. In fact, sometimes there are serious functional flaws in their buildings. But striking, original forms are received with so much admiration by the public at large that functional flaws are often met with forgiveness. In this respect, architecture occupies possibly a unique position as far as the balance of novelty and effectiveness in creativity is concerned, and in that it is closer to the visual arts. For example, the Sydney Opera House by Jørn Utzon, completed in 1973, cannot carry out all the functions that those who commissioned and paid for it envisaged (the staging of large-scale opera productions). However, because it looks beautiful this flaw is forgiven. By contrast, it is impossible to imagine public acclaim being given to, let us say, a bridge that was built at great cost to carry traffic across a river but turned out to be useless because of engineering flaws, even though it looked beautiful. Thus, to some extent architecture is less bound by the insistence on function as part and parcel of the definition of creativity in the literature. (see also the chapter on: *Definitions* within the Encyclopedia that novelty must be effective).

Architectural Education

The history of university-level professional education in architecture is relatively short. Before World War I, the great majority of schools of architecture in the western world were modeled after the French *Ecole Supérieure des Beaux Arts*, which was founded in the seventeenth century by the *Académie Royale d'Architecture*. Its main purpose was to serve the needs of French aristocracy. Throughout its long existence, Beaux Arts education promoted the value of historical precedents and the primacy of the great classical traditions. The Beaux Arts educational system was extremely influential and many a school in Europe and beyond followed its tradition and were hence identified as Beaux Arts schools (to distinguish them from schools of other ‘denominations’). Leading nineteenth century American architects went to Paris to study at the *Ecole des Beaux Arts*. A Beaux Arts diploma was in good currency in the USA well into the twentieth century. Creativity was not a prime goal of standard Beaux Arts education (with exceptions in the last years of its existence); the fostering of creativity and innovation had to await a later major cultural shift. European Beaux Arts schools of architecture were widespread until the 1960s, alongside other types of schools, notably the ‘Polytechnic’ institutes and schools that reflected the ideology of the Modern Movement. In France the Beaux Arts system was abandoned only after the events of 1968.

An alternative model of architectural education was launched in the 1920s in Europe in two avant-garde institutions, the Bauhaus in Germany and the Vkhutemas in Russia. In both institutions architecture was a unit alongside other units devoted to the arts and to crafts. The foundation of the new schools resulted from novel cultural attitudes and from reforms in education prevalent in contemporary arts, design, and architecture in the aftermaths of World War I and the Russian Revolution. These reforms, which rejected classicism, were strongly motivated by a social and political agenda and by a wish to empower the arts, the crafts and design through the use of industrial and technological advances. Experimentation and creative initiative were central to the educational philosophy of the Bauhaus and the Vkhutemas, as opposed to the conservative approach of the academies, embodied in Beaux Arts education. Although the avant-garde Bauhaus and Vkhutemas were shut down prematurely due to the political circumstances of the 1930s in Europe, they exerted a lasting influence on architecture and architectural (and design) education. In fact, the term Bauhaus has become an emblem of the modern movement in design and architecture, still in wide use today (and often erroneously replacing International Style).

The second half of the twentieth century has seen a phenomenal growth in higher education, for which the university has become the prime vehicle. Many new universities were founded around the globe. The great majority of schools of architecture, whose number has surged proportionally, operate today as academic departments within universities, sometimes independently but often in partnership with other departments (e.g., planning, construction, environmental studies, engineering, or art). Despite the many differences among schools of architecture and their institutional contexts, almost all of them share similar goals and the programs they offer are based on training principles that were, to a significant extent, inherited from the Beaux Arts and the Bauhaus-Vkhutemas traditions. The omnipresent design studio, central to the curriculum of every school of architecture, is a direct descendant of the Beaux Arts’ atelier. Striving for originality and innovation and the legitimization of exploration and search by trial and error have been handed down from the Bauhaus and Vkhutemas, and today creativity is the single most valued capacity students are expected to demonstrate. A similar development is now being seen in technological design education, as well as in other areas such as entrepreneurship education, where creativity is receiving much greater attention as a goal of teaching (as against for instance,

mastery of techniques or tools). Accordingly, the role of the studio teacher has evolved: from studio 'master' (or 'mistress'; until a few decades ago, architecture was a predominantly masculine occupation and most teachers were men) to what is sometimes referred to as 'coach'. Needless to say, new curricular components have been and continue to be added to professional education to catch up with technological and scientific developments, notably computational options and new building materials, as well as dynamic social and environmental sensitivities and awareness.

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Artificial Intelligence

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Introduction

I have spent most of the last 20 years moving back and forth between two areas: As a practitioner I have developed AI software and used it to support decision makers. As a scholar I have been studying the human mind, focusing particularly on the highest level of expertise and on elusive phenomena, such as intuition and creativity. Naturally, I got interested whether AI can perform on par with the human mind, supersede it, and whether there is anything unique in the human mind that cannot possibly be achieved by AI as expressed through machines. Ultimately, my most important question always has been how to create a synergy between human mind and AI; in other words, I became interested in what is recently referred to as Augmented Intelligence.

Why is it useful or perhaps even necessary to have a chapter on AI in a creativity encyclopedia? The first, and perhaps, the most obvious reason is that many people today want to know whether we can ever expect AI Creativity (Amabile, 2019). Second, if there is a chance that AI can play a role in human creativity, it is worth exploring. The third reason, conceivably the least obvious one, and the most significant in my view, is that understanding AI (even in non-technical terms), can help creativity researchers understand human creativity better. The reason for this significance is that as we are trying to build AI, we must use what we know about the human mind, and in the process, we achieve greater clarity of the limitations of our understanding of the human mind. This is perhaps the most obvious in the case of creativity. For instance, we often intuitively classify an achievement as creative, and we do not think about explaining what makes it creative. However, if we compare such creative achievement with a similar or even superior achievement by AI, we do not necessarily want to label it as creative. This makes us think about what qualifies some achievement creative. In other words, if we want to put something into a machine, we need to put it into words, and in order to put something into words, we need to understand it. Therefore, my primary focus in this chapter is this third reason, although I will briefly address the other two as well.

The term artificial intelligence denotes both making intelligent machines as well as studying them. In line with the above argument, AI gurus, such as Herbert Simon, often noted that the field of AI includes studying the human mind. AI is loosely defined as machines that can accomplish tasks that humans would accomplish through thinking (through intelligence, as intelligence in AI is considered much broader than psychometric intelligence). It is interesting that the definition does not say anything about accomplishing such tasks the same manner as humans do; I will get back to this point below. To set the scene, I start with a brief overview of the history of AI.

A Brief History of AI

There are two distinct roots of AI, one is usually referred to as symbolic AI, the other connectionist AI. These two roots have come together, to a varying extent, in today's AI applications, but started as separate roots. Before the "AI-era" began, there was, however, one important work published where Alan Turing (1950), in his seminal paper, introduced the Turing test, machine learning, genetic algorithms, and reinforcement learning. In many ways we could say that we are still working our way through the challenges outlined by Turing.

The Symbolic Approach

According to the AI folklore, the history of AI began when Herbert Simon returned to the Carnegie Institute of Technology (today Carnegie-Mellon University) after the New Year in January 1956 for his class on Mathematical Models in the Social Sciences and told

his students: “Over the Christmas holiday, AI Newell and I invented a thinking machine”. One of the students in the class was Edward Feigenbaum (1992: 3), who recounts this sentence as the reason to become Simon’s PhD student, and who was later to become the father of knowledge-based expert systems, one of the important areas of AI. During the same year, a conference was organized in the Dartmouth College, at which John McCarthy coined the term “Artificial Intelligence”.

The Logic Theorist was the “thinking machine” that Newell and Simon created together with Cliff Shaw from RAND Co., the company that gave them access to a computer (a power-hungry IBM 701 with less than 20 kb memory, using unreliable vacuum tubes, costing millions of dollars). The Logic Theorist was supposed to try to find solutions to complex problems, such as proving mathematical theorems, when it is not even known if there is a solution. The Logic Theory Machine project was followed by the more ambitious General Problem Solver (GPS), which was supposed to extend this scope to any and all problem areas, such as deriving scientific rules from data or playing chess. This should have been achieved by following the steps of human problem solving, and replicate achieving the outcomes (i.e. solutions to the problems). The idea was that if we do this across a number of problem areas, we could develop AI that could apply the general principles of reasoning, and thus would not only work within a narrow well-defined scope, but across various domains. This type of AI is also referred to as “wide-AI” or, more recently, Artificial General Intelligence (AGI).

Moving to Berkeley, away from the direct influence of Simon and Newell, Feigenbaum got more and more interested in creating a machine of superb performance, possibly superior to human performance. Instead of focusing on the general principles of reasoning, he focused on the role of specialist knowledge at a high level of expertise. His dream was to build a super-intelligent machine. As he realized that the previous AI solutions were good at deductive but not so good at inductive reasoning, Feigenbaum was looking for a problem in which hypothesis formation could be captured by inducing internal models of external environments. Partnering with the Nobel Laureate Joshua Lederberg, he ended up with the problem of inducing topology of molecules based on their mass spectra. The DENDRAL project, as it was called, lasted for many years, involved further subject area experts, but at the end, the program was performing at the level of the top experts. This was the first knowledge-based expert system. A system being “knowledge-based” refers to the internal model called “knowledge representation” which was stored in the form of a “knowledge base”, while the term “expert system” signified that expert knowledge was being modeled.

Both, the GPS (and the previous Logic Theorist) and the DENDRAL relied on a process called “knowledge acquisition”, through which human thinking about a problem was captured in the form of logical “if... then” rules. As such rules can be implemented as symbol manipulations, such systems became known as symbolic logic, or symbolic AI. There was, however, a great divide between the two directions in symbolic AI. One direction was to attempt building a domain-independent AGI, through capturing the generic process of problem solving. The other direction was to build expert systems (or knowledge-based systems or knowledge-based expert systems) in a well-defined narrow area by modeling subject-specific knowledge of experts. Knowledge bases typically comprised a few hundred to a few thousand “if... then” rules, they rarely reached the range of tens of thousands (and this was inevitably only possible by involving multiple experts).

Knowledge-based expert systems dominated the AI landscape until the mid-1980s, producing a large number of very successful implementations in a wide range of areas from science through manufacturing to medical treatments. At the same time, the AGI approach did not produce any implementations that would successfully work across multiple domains, but some implementations were successful in narrow domains.

The Connectionist Approach

While the symbolic approach to AI was dominating the early days of AI, the connectionist approach has been developed earlier. The first Artificial Neural Network (ANN) implementation was done by Marvin Minsky and Dean Edmonds, as part of their graduate work at Princeton in 1951. The purpose of these ANNs was to demonstrate that any mathematical function could be calculated by a suitable network of artificial neurons; therefore, this was not what would today be regarded as AI, but might be regarded as “pre-AI”.

ANN, however, became somewhat dormant until the mid-1980’s, when it had a big comeback. There were several reasons for this comeback. The AGI approach did not produce any solutions that would work across domains, expert systems were confined to their narrow areas and took extremely long times to develop (often becoming obsolete once the problem was solved), and computers became sufficiently fast to cope with ANN of a useful size. ANN are today perhaps the most heard of forms of AI, in fact, ANN seems to have monopolized much of the AI area, including the concept of machine learning. Therefore here I provide a very much simplified but in-principle correct description of what ANN are and how they work.

Any ANN consists of three layers of artificial neurons. There is an input layer, that receives some kind of signal (stimulus)—a stimulus can be more or less anything we can convert into an electronic format. Then there is a hidden layer, which performs some sort of black-box operation between the input and the output. Finally, the output layer produces a response to the stimulus received by the input layer. Nowadays we often hear terms like “deep ANN” or “deep learning”, which sound mystical and exciting; in fact, these simply mean that there is more than one layer of artificial neurons in the hidden layer. Computationally this makes a great deal of difference, but logically the concepts are simple. The artificial neurons are connected to each other across the layers, like synapses in the human brain, hence the term connectionist approach. Each connection has an initial weight, so as the stimulus “ignites” the system, the signal propagates toward the output neurons resulting in a response. The response is compared to what was expected, the weights are adjusted, and the process is repeated iteratively. As it is easy to process a large number of learning samples

(stimulus and the desired response), the ANN can relatively quickly adjust to producing the desired response. In other words, ANN learns from a large number of learning samples how to reproduce the statistical frequency of those learning samples.

So the logic is simple, but then comes a twist. As the artificial neurons were modeled after the biological neurons, more precisely after our knowledge of the neurons at the time, the ANN, supposedly, resembles the human brain. Therefore, so the argument goes, if we put together a sufficiently large ANN, it should think. Furthermore, as the digital neurons are faster than the biological ones, these machines should be, following this line of thought, smarter than humans are. Although this logic may appear sound at the first sight, it is heavily based on assumptions and beliefs, and also seems quite unrealistic for the present times – at least to me. Let me unpack this assertion.

My first point is about the size of ANN. The human brain is taken to consist of about 100 billion neurons, with around 7000 connections on average, resulting in some 1000 trillion (10^{15}) synapses in total. The largest ANN I have seen consisted of a few dozen artificial neurons, although I know that there are some in the hundreds. It is not public knowledge how many neurons the most advanced ANNs, such as the one in DeepMind, comprise today but I would expect a few thousand. In these exceptionally advanced systems, an artificial neuron perhaps may have a few hundred connections. This means a few hundred thousand synapses in total, suggesting that ANN is only about 10 orders of magnitude short of the human brain's network. True, in the last 70 years ANN architects managed to achieve an increase of 4 orders of magnitude, so another 10 does not sound like science fiction. But it is surely reaching the level of complicatedness (rather than complexity, see later) which cannot be grasped by the architect anymore; the only way to analyze such huge AI is using AI. In other words, I am hesitant to believe it is only a matter of time until we produce functioning ANN of a similar size as that of the human brain.

My second point is about the structure of ANN. In such a network the connections always go forward, that is a neuron from any layer only connect to the ones from the next layer (in some networks there can be within-layer connections as well). We do not really know if there are any circular connections in our brains, but there may well be. Furthermore, I am not even sure that we should think in "layers" about the brain. In other words, while structurally ANN resembles the brain in being complicated, a closer look at the structure also reveals dissimilarities.

The third point concerns the functional aspect of ANN. The functioning of artificial neurons reflects what we knew about biological neurons around the mid-20th century—that neurons are either "firing" or not, resembling the digital computers. Today, it seems that at least a small subset of neurons (maybe only a few million?) displays a more complex behavior, more akin to analog computers. This means that functionally ANN is rather limited in comparison with the human brain.

If ANN architects managed to overcome all the difficulties of the previous three points, they could construct something like an artificial brain. Some enthusiasts emphasize that as the artificial neurons are faster than the biological ones, the artificial brain should be better, or at least faster, than the biological one. However, here we face another assumption barrier: that the brain, if structurally, dynamically, and functionally adequate, would produce the mind. It may be that many find this assumption plausible, but it is just a belief. However, what science knows so far is that the brain and the mind are somehow connected, and particular thinking processes can be associated with neural activities in particular areas of the brain. We do not really know whether the brain produces the mind, the mind produces the brain, they co-produce each other, or the brain and the mind are produced separately and linked. The typical computer science analogy for cognition is that the brain is the hardware and the mind is the software—although the software is running on the hardware, hardware has never produced software.

Finally, recent research also suggests that the brain is not the only part of our biological setup that participates in our cognitive system; our endocrine systems also seem to be part of it, and I would not be surprised if we found in the coming years that our whole body is, meaning that the mind is fully "embodied". In other words, if an artificial brain was produced, reasonably approximating the human brain in size, structure, and functioning, this does not imply that it will produce an artificial mind.

AI Paradigms

I have noted above two divides in AI. The first divide is between the symbolic and connectionist approaches, a divide which is technologically fundamental. There are further tools and implementations that belong in the AI landscape, such as fuzzy logic and genetic algorithms. I have not gone into the details of these here, as they do not offer different approaches to AI. Fuzzy logic is usually used in a connectionist way, in combination with ANN or on its own. Genetic algorithms are well aligned with ANN, and they could be used in symbolic AI as well—although I have only seen examples of this in computer games. The second divide is between artificial general intelligence (AGI), aimed at wide application area with less concern on current performance, and expert systems, aimed at high performance in a narrow area. In this section, I introduce a third divide, which is somewhat like an extreme version of the AGI versus expert system divide; these are the paradigms of AI: strong AI versus weak AI (referring to strong versus weak assumptions).

Strong AI means creating a thinking machine that equals humans in every cognitive aspect. According to the proponents of strong AI, these machines were not only expected to think, and deliver performance that is on par with human, they were also expected to think the same way as humans do. This kind of AI is expected to awaken to self-consciousness, and have intentions, emotions and sensitivity. In principle, there are two ways to achieve strong AI. The first way is to attain a complete understanding of the human mind and then the ability to replicate it artificially. Unfortunately, or luckily, depending on where you stand, we are nowhere near to being able to understand the human mind. If we take complexity theory seriously, we have to accept that we cannot ever achieve this, as no system can understand another system that is at least as complex as itself. The second way to achieving strong AI is to admit that the human mind cannot be fully understood, at least for now, but maintain the belief that it is possible to create

an artificial brain that will then produce an artificial mind, which is like the human mind as we know it. Based on everything stated above, and on what most AI experts say, having a human-level and human-mode thinking machine cannot happen in the near future. However, there are a few enthusiasts, some of them the greatest minds of AI, such as [Simon \(1977: 6\)](#), who said:

"I believe that in our time computers will be able to perform any cognitive task that a person can perform. I believe that computers already can read, think, learn, create ..."

Those who subscribe to the weak AI paradigm, believe that we do not, at least currently, understand the human mind well enough to reproduce it. Perhaps even more importantly, they want to align their efforts with a purpose that sounds less grandiose, but is aimed at producing useful and meaningful results right now. So they want to build specialist applications, such as expert systems, that work well in a narrow predefined domain, and only performance is of interest, it does not matter if the machine achieves it in the same way as a human would. My personal beliefs are closer to this approach and, as a practitioner, it is certainly my preference to produce something that works right now. I always tell my students a metaphoric example: "When they wanted to go somewhere, our great-grandfathers called a carriage. Today we call a taxi. The taxi is not an artificial horse, it works on completely different principles, but can do the same job of taking us where we want to go, in a different way, perhaps even better (e.g. more conveniently and faster). In order to make the taxi, we did not need to understand everything about the biology (and perhaps even psychology?) of horses, we had to understand the internal combustion engine and the wheel. Of course, the taxi cannot substitute the horse in every task, for instance we cannot play polo on it. But it can take us where we want to go". Similarly, today we understand a lot more about computers than we understand about the human mind. And we can make useful tools using computers, using AI. AI is far better at many things than humans are, often these are things that humans do not find particularly interesting anyway – and it cannot do some things, at least for now, that humans find easy. Then, again, this is also true for a seeding machine or a coffee mill.

To be fair to those in the strong AI paradigm, they do produce things that work right now. The stories on the websites of DeepMind or Watson show a number of projects that are incredible, useful as well as meaningful, while others are interesting and funny. Perhaps it would also be fair to say that DeepMind and Watson transcend the strong-weak AI paradigmatic divide.

What AI Still Can't Do—and What It Does Well?

So how do we know that a computer is thinking? How do we know if it should be considered (artificially) intelligent? The first criterion is the Turing test ([1950](#)), which is still usually referred to as a qualifier. The essence of the Turing test is that if we interact with an entity and we cannot figure out whether we are talking to a person or to a machine, and it is in fact a machine, that machine should qualify as intelligent. On first sight this sounds convincing—if the machine is not really thinking, we should be able to catch it out. So has any machine (computer program) passed the Turing test so far? Yes, quite a few did, from ELIZA through a number of chatbots, to Eugene Goostman, the simulated 13-year-old Ukrainian boy, and an AI course moderator at MIT. Instead of getting into the details whether these instances of passing the test were legitimate, let me ask different questions. So what if a machine passed the Turing test? Would that really mean that it was thinking in the sense we attribute this verb to humans? No, I do not think so. The programs that passed the Turing test were designed with this purpose, not with the purpose to think.

Perhaps the most convincing argument against the Turing test comes from John [Searle \(1998: 11\)](#)—that became known as the "Chinese Room Argument". The essence of the argument is the following: assume that I do not speak Chinese, and I am in a room full of rule-books, receiving messages in the form of Chinese symbols and looking up responses to those messages in the rule-books. If the rule-books are good, those outside the room, receiving the responses, would believe that the person responding understands Chinese. And they would be wrong, I did not miraculously learn Chinese. The same way, passing the Turing test does not prove that the computer thinks, only that the program is good.

[Minsky \(2006\)](#) reposts to Searle by reversing the Chinese Room Argument, creating a hypothetical "zombie machine". The zombie machine is seemingly identical to the human and, if it injured a leg, it would complain about the pain (as it was programmed to do so). The response to the pain would be indistinguishable from a human with a pain in the leg. If this was done, could we claim that the zombie machine's leg does not hurt—that it does not feel? But the most brilliant part is the final turn: if we cannot distinguish the zombie machine from a human being, can we claim that the human being feels?

Of course, none of the above proves that the machine does not think, the arguments only falsify the validity of the evidence that it does. So, we are left to our beliefs as there are no conclusive proofs. Another important thing that we can learn from the above is that we do not have a way to directly measure knowledge or thinking, what we can do is make inferences from the performance. This is not a unique situation in the world of science, all the work done in quantum physics is similar, elementary particles cannot be put under a microscope and it is impossible to measure their weight or speed or similar. What physicists do instead is to observe interactions of elementary particles and infer their characteristics. Physicists come up with models, speculatively, conduct experiments in which they measure some effects, and from these they infer various characteristics and check whether these are consistent with their speculative models. That is probably the reason that there is no single model accepted by all quantum physicists. Many different models can be consistent with the same results, depending on our inferences.

So, instead of trying to prove that AI can or cannot think, it is perhaps more useful to look at the performance of AI and the related claims. In 1957 Herbert Simon announced that the chess world champion will be an AI machine within 10 years. However, it was only in 1997, four times longer than Simon predicted, that Deep Blue defeated Garry Kasparov, who is possibly the best (human) chess player of all times. Since then we had AlphaGo defeating the world champion Lee Sedol as well as all the other Go grandmasters, AlphaGo Zero winning consistently against AlphaGo, and AlphaZero beating not only the previous two but also the best computers in chess and shogi. Let me unpack how AI achieved this extraordinary performance and what it means.

There are four different “pure” ways for AI to become “smart”. The first is to hardcode a program specific to the chosen performance area. These are “purpose-built programs”, such as Deep Blue which was programmed to play chess. The second way could be termed “process capturing”; it characterizes the previously mentioned Logic Theorist and the subsequent General Problem Solver. The essence of this approach is to record the steps of problem solving by human experts using the “thinking aloud” technique. The third approach is “knowledge representation”, which is primarily used by knowledge-based expert systems. Knowledge engineers build knowledge bases from knowledge acquired from domain experts, while the processes of how these knowledge bases are used, are programmed. Finally, the fourth approach, “machine learning”, is to let AI learn with or without humans interfering with the process. This approach is predominantly associated with ANN, but all forms of machine learning belong here, including those in the symbolic AI realm (e.g. [Quinlan, 1986](#)). Of course, apart from these pure approaches there are also various mixed approaches within and across these categories.

Each of the above approaches has at least one of the following two characteristics: they require *explicit knowledge* or they follow a *reinforcement learning process*. Both of these impose severe limitations on what we can expect AI to do. In fact, these limitations should be sufficient in themselves to convince most people that AI, as approached today, can never think and learn in the sense of human thinking and learning. This also suggests that AI Creativity, in the human mode, is impossible. This is explored at a greater depth in the next section; here I want to examine the broad implications of these two characteristics.

The first characteristic limits human knowledge to explicit knowledge. While it is widely known that humans also have, and use, tacit knowledge, [Polányi \(1966: 7\)](#) goes much further claiming that there is no knowledge without tacit knowledge:

“While tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is either tacit or rooted in tacit knowledge. A wholly explicit knowledge is unthinkable.”

Considering that much of what we know about knowledge today originates from Polányi, we must take seriously his assertion. AI that uses any form of knowledge representation, hardcoded, in the form of knowledge bases or as embedded problem solving steps, is limited to explicit knowledge. This explicit knowledge is always used in the process of formal logic, and even Simon, who was extremely optimistic about the prospects of AI, warned that formal logic is only one of the instruments of reasoning. Knowledge-based expert systems respond to this limitation by focusing on a narrow domain and fine-tuning the knowledge bases together with the domain experts, until it reflects their judgments. In the process, occasionally, something in the tacit knowledge of the experts becomes explicit, that is, something is spelled out that the experts already knew, only they did not know that they knew it. This rare event is called “knowledge discovery” and is often considered to be the most valuable aspect of the knowledge engineering process.

Limiting learning to reinforcement learning is at least as significant a departure from human learning as limiting knowledge to explicit knowledge. There was a period in the history of psychology, called behaviorist psychology, when reinforcement learning was considered to be the only way of learning. While it was therefore sensible for Turing to suggest reinforcement learning in 1950, psychology has come a long way since its “dark ages”, when it denied its own topic of research considering the mind a black box. At the heart of the reinforcement learning approach is the stimulus-response (S-R) model; the entity (human, animal, machine) receives a stimulus and provides a response. We reward the preferred response and/or punish the non-preferred ones. Sooner or later, the responses will align with our preferences, and this is considered learning. Of course, there are a few things that humans learn this way, for example a child will quickly learn not to touch a hot stove. However, we also learn from stories, get inspired, are talented for some things and not for others, commit to master-apprentice relationships, etc. Reinforcement learning covers only a tiny part of our learning.

Both of these issues, limiting knowledge to explicit knowledge and limiting learning to reinforcement learning, are captured in the concept of “common sense”, contrasted to specialist knowledge. As [Minsky \(1988\)](#) said, it seems to be easier to create AI that performs at an expert level in a narrow domain than to make a program which could play children’s games or bring in the newspaper from the front door to the breakfast table. According to Minsky, common sense is an immensely complex system of rules, and exceptions, practical ideas, dispositions and tendencies, balances and checks. It appears simple and natural as we have lost touch with how we learned them—and we know almost nothing about how common sense is acquired. Interestingly, most researchers from strong and weak AI paradigms agree that the missing link to creating a thinking machine, and by implication AI Creativity, is the model of common sense. The difference is that according to the strong AI community it is only a matter of time before a model of common sense is obtained, while according to the weak AI group it is impossible. There were several attempts to develop artificial common sense, among others the “CYC knowledge base” (by Cycorp), which is probably the largest knowledge base ever produced, comprising “millions of facts, beliefs, and other bits of knowledge” ([Feigenbaum, 1992: 17](#)). All these attempts have remained futile

so far and none showed any promising progress toward modeling common sense. Perhaps, it would be sensible to ask whether there is any meaningful concept of intelligence (human or artificial) at all without common sense.

The above is a sufficiently convincing argument that AI does not think or learn the way humans do. However, this does not necessarily mean that AI does not think or learn in ways that are different or only partially overlapping with the human ways. As I indicated previously, to deliver a particular performance, it is not necessary to do it as humans do – and we can see that AI can beat us in areas like the game of Go. All the success stories, however, are in relatively narrow domains. With rare exception, such as DeepMind and AlphaZero, this means one single problem area. DeepMind is usually represented as a wide-AI. However, it does not cover the whole spectrum of human problem solving, it only plays various computer games designed for Atari computers (an early PC of the 1980's), while AlphaZero plays Go, chess and shogi. Although it is a significant step forward that DeepMind (which is also at the core of AlphaZero) can cover more than one domain in a single system, playing the different games is very far from covering a full range of human problem solving, such as leading an organization, writing a poem, nursing a patient, or enjoying a football game (as a fan). In short, there is convincing evidence that artificially reproducing thinking and learning (and by implication creativity) in a human mode, is impossible, at least for the time being. In the next section, I explore how AI does in the area of creativity, which is traditionally considered a particularly human endeavor.

Creativity and AI?

Can AI be creative? If we reverted to Polányi's above assertion, the short answer would be a sound "no", because, as the renowned philosopher of science, Karl Popper (1968: 8) put it:

"[T]here is no such thing as a logical method of having ideas, or a logical reconstruction of this process. My view may be expressed by saying that every discovery contains «an irrational element», or «a creative intuition», in Bergson's sense."

In other words, we know that intuitive insights (Dörfler and Ackermann, 2012; Dörfler and Eden, 2019) play a significant role in human creativity, they appear to be a necessary ingredient, and they belong in the realm of tacit knowledge, therefore AI Creativity, in a human mode, is impossible. However, it is worth considering whether there can be AI Creativity in a way that is different from how humans do it. In order to explore this further, it is useful to reconsider the AI track record so far and how these relate to the definition of creativity.

There are many claims about how AI will create at the finest level of human creative performance, such as writing a Shakespeare-level prose as suggested by Minsky (Amabile, 2019), and according to some this has already happened. One of the earliest acclaimed creative achievements of AI is the Logic Theorist (LT) coming up with a proof for one of the theorems in the Principia Mathematica that is according to Alfred North Whitehead "more elegant" than the one he and Bertrand Russell provided. This was definitely something new and useful—the two criteria of creativity. However, if we use the original definition of creativity by Teresa Amabile, as a novel and useful idea, it has a hidden third requirement: it also has to be an idea. While the details of how the LT did this requires some technical knowledge, it is easy to see that the process is transparent and fully explicit—contrary to how we see the human creative process. Can it help if we ask an appropriate group of judges to evaluate whether an AI outcome is creative and to which extent? The inadequacy of the Turing test suggests that this is not the case. To elaborate this, let us look at the two great game achievements, namely Deep Blue defeating Kasparov and AlphaGo defeating Lee Sedol.

In both cases there was a master-stroke, that shocked the human players and was highly praised by the chess and Go experts respectively. In the case of Deep Blue, a programmer later on said that there was a glitch in the system, caused by a bug that was subsequently fixed, which did not allow Deep Blue to choose one of the evaluated steps, so it went ahead with a random step instead. As in the Chinese Room argument, it was Kasparov who put the sense into this step. AlphaGo had a move against Lee Sedol that corresponds to all the rules but was never made by a human Go master. The reason is that Go has an enormous number of possibilities (and therefore it is more complicated, although less complex than chess), and the tradition evolved toward playing line 3 or 4 in particular situations and nobody ever played line 5. However, as AlphaGo, during its "training period", played some 300 billion games (which would be many grandmaster lifetimes) against itself, it built a database of moves, and the surprising move had a higher probability for a win in that particular situation. A first look at these stories suggests that there was no creativity, in the human sense, demonstrated by AI in either case. However, if that was all we could learn from this case, it would not be worth going into such detail—there is much more.

If we relax the definition of creativity to include "ideas, problem solutions, or other outputs" (Amabile, 2019: 3), the two moves, as well as the above mentioned mathematical proof provided by LT, could qualify. I would be still hesitant to consider these achievements creative, as it is fairly visible how they were achieved, and looking up maximum probability from a big table intuitively does not appeal as creative. If we think about this, the move by AlphaGo was new to the human Go masters, but it was not new for AlphaGo—it must have made it many times, if it had high probability for a win. Was it a new move when AlphaGo made it the first time? It probably was, but randomness seems to have more to do with this than creativity.

Nevertheless, these examples do give us an important glimpse into how AI can play immensely useful role in human creativity. AI is really good at quickly analyzing large amounts of data, identifying patterns in vast sets of facts, things that require precision.

That is why Thomas Davenport (2018: 44) says that AI is “analytics on steroids”. Humans are not very good at these, and even if we managed to do it, it would take far too long. What AI is not so good at, is judging which pattern is, or may potentially be, significant in the situation at hand – but human experts excel at this. For example, if an oncologist and a chemist are working with some chemicals trying to achieve an effective cancer treatment, AI may produce an incredible number of combinations of chemicals at hand, but it cannot judge which resulting compounds may be of interest, beyond meeting predefined specifications. However, the oncologist and the chemist may figure out, looking at some of the characteristics of the new compounds produced by AI, whether there are some new (unexpected) combinations which may be useful for curing cancer. Furthermore, human experts may also notice that some of the resulting compounds may be useful for treating kidney stones, for instance. The reason that AI could not pick up on these is that the solution is in a different realm than the original problem. The knowledge of the two doctors was necessary for figuring out the significance of the new pattern uncovered by AI. Similarly, designers in fashion, furniture, automotive and other industries use AI today for coming up with potential new models. While AI can deliver new models (by rearranging existing patterns), it is the designer who chooses which one is aesthetically appealing. Therefore AI can provide pre-processing in the sense of identifying and organizing patterns, and so can add immense value to the human creative process.

There is an additional perhaps less trivial value that AI can add. High-level human creativity is closely associated with domain (discipline or problem area) expertise. Such high level of expertise takes time to develop. And, like all the Go grandmasters in the world, experts often lock themselves up “inside the box”, imposing unnecessary but conventional limitations. In fact, the triumph of AlphaGo revitalized the world of Go: human Go grandmasters are reporting new moves, new strategies, increased openness, and going beyond the approaches of the traditional schools. Consequently, although it may sound initially surprising, AI can help us think “outside the box” in the best sense of the term.

Concluding Remarks

In the prologue of his book called *The Emperor’s New Mind* (paraphrasing Hans Christian Andersen), Roger Penrose (1989) introduces a mythical supercomputer Ultronic, which was set up in the Grand Auditorium, and the citizens were invited to ask any question. As the computer knew everything, it should be able to answer any question. People felt “bashful, afraid to seem stupid”, intimidated by such a super-smart entity, so nobody dared to ask any question ... until the thirteen year old Adam dared... The story is concluded in the Epilogue of the book, Adam asked the super-smart computer what did it “... FEEL LIKE”, to which Ultronic responded that it didn’t see what and couldn’t even understand what Adam was getting at and then everyone was laughing. The supercomputer with 1017 logical units, which was supposedly making it more intelligent than the combined intelligence of the whole country, could not handle such a tough question.

In this chapter, I have provided a personal view of AI in the context of creativity. I have tried to paint a rich picture of AI, not aiming at comprehensiveness or immaculate precision of the details, but rather at intuitive understanding of the essence. However, I also tried to be faithful to what can be known about AI, bringing it closer to the reader. Herbert Simon (1995: 508) said that it was time to stop philosophizing and to focus on empirical (and particularly experimental) testing. While I agree with Simon about the value of empirical work, I think that philosophizing about AI was never as timely as it is now, in order to delineate beliefs from facts and to demystify what AI can actually do. Unless we do this, AI is in the danger of becoming a brilliant solution in search of an appropriate problem (as Theodore Roszak said about computers in general), rather than a brilliant solution to a range of problems in a variety of areas, including creativity.

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Arts Bias

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'Arts bias' refers to the tendency to think of creativity in terms of aesthetic forms such as painting, music, poetry and theater. While art-centric views were dominant up until the early 20th century, understandings of creativity have since expanded to include activities as diverse as home crafts, warfare, manufacturing, management, advertising and technology, among many others. Current debates over arts bias are symptomatic of the ambiguities surrounding evolving definitions of creativity. Significantly, many of the newer 'arts' of creativity differ from conventional understandings of aesthetic creation in a key way: they bring to modern definitions of creativity (see "originality and effectiveness" in [Runco and Jaeger, 2012](#), p. 92) a distinctly utilitarian aspect. Technology, especially data-driven, information storing and social connection systems, have emerged as the defining example of 21st-century creativity.

Art is frequently perceived as inherently lacking in usefulness. In a discussion of the "outstanding permanence of art", Hannah Arendt noted that the proper intercourse with a work is not "using" it. As art is "removed from the wants and exigencies of daily life", she argued that the intense worldliness and consistency of art serve as a lasting symbol of the stability of human artifice; as something "immortal achieved by human hands" (p. 167–168).

Notions of immortality and permanence are closely tied up with longheld ideals that artists possess special, imaginative powers, such as the divine inspiration afforded to poets as described by Plato, for example. These conceptions of elite skill (typified by classical, Romantic and early 20th-century artists such as Mozart, Samuel Taylor Coleridge and Picasso), are precisely the kind of ideas which some current researchers view as "damaging", "incorrect", "flawed", potentially 'harmful', ([Patston et al., 2018](#), p. 367) and 'dangerous' ([Cropley, 2014](#), p. 368). In their view, bias toward artistic disciplines risks obstructing more diverse and productive understandings of creativity. This is especially so given that "the global economy is shifting to a new paradigm", and the world of work now requires students to prepare for having many careers and developing high levels of creative intelligence to avoid losing work to automation ([Patston et al.'s p. 367](#)).

Yet as authors such as Oli Mould assert, in 21st-century media and government discourses there has been a strong focus on, indeed, a bias toward, forms of creativity that drive neoliberal capitalism, such as technology, design, advertising and finance ([2018](#)). The 2015 United Nations Creative Economy Report for example showed that already in 2012 new media and design made up 69% of all recorded creative output globally, while the performing arts made up only 1% (p. 2). Mould argues that conceptions of 'the creative industries', 'the creative class' and 'creative cities' (coined by Richard Florida and adopted by OECD governments since the turn of the century) have helped to shape neoliberal policy and discourse.

The tension between acts of creation which are useful and acts which only illuminate something about the human condition (especially experience and emotion) is the central issue which will be explored in this entry. It will be argued that non-human, machine-led creativity in art-making and other domains also raises questions about bias. Computational artmaking challenges long-held presumptions that creativity is anchored in, and must emerge from, human feeling and being in the world.

The New Frontier: Machine-Led Creativity and Art

Although computational creativity is not naturally associated with the ideas, perceptions and feelings of traditional art ([Jones, 2018](#)), engineers have for some time been working on replicating artistic forms. Their attempts to control and catalog the ways art is produced and consumed perhaps even suggest an implicit and ongoing bias toward art. Such pursuits also invite reflection about why artworks are valuable in the first place, and what – beyond economic gain – is really driving the desire to apply new tools, such as algorithms, to artmaking.

In 2009 Pablo Gervás documented how programmers were focused on mastering a wide range of cognitive abilities to achieve the "complex intellectual product" of storytelling. The skills that interested artificial intelligence workers included: the perception of space and time, the invention of multi-dimensional characters, and the successful design of make-believe worlds within which intricate plots could play out ([Gervás, 2009](#), p. 50–51).

Since machines have begun to try to 'manufacture' artistic creativity, data has become increasingly central to storytelling production. However, Sebastian Wernicke has proposed that human insights and instincts are still far from obsolete ([2016](#)). He compared

Netflix's globally successful *House of Cards* (created by playwright Beau Willimon) and Amazon's *Alpha House*, which also depicted US politics but relied more exclusively on data about television consumption to make its artistic decisions. Wernicke showed that the gut instinct to go with a concept which had sprung from Willimon's human imagination illustrated something about the current limits of machines to originate and conceive of stories worth telling.

Wernicke's conclusions mirrored Tricia Wang's research on "the human insights missing from big data" (2017). Wang also stressed the importance of 'intuition' in developing and marketing new technology products, as well as the significant difference between a machine's capacity for reflecting complex patterns of what already exists, versus a human's ability to conceptualize new trends based on lived experience and consciousness.

Data and machines have also been used to produce fine art. The French group Obvious have been using what they call "a different type of paintbrush" to produce 'Rembrandts' from the datafication of hundreds of existing originals (Cabrera, 2018). In London an exhibition called *Chance and Control: Art in the Age of Computers* (2018) showed the now extensive evolution of art-making with machines dating back to the 1950s.¹ According to computer arts author Catherine Mason the collection showed how "working with code does give the capability to produce random events; pseudo-random number generators can be introduced into the program to produce unexpected elements within a planned structure" (2018).

Proponents of computer art face the criticism that such work is only a "poor pastiche" of what is innately human (Jones, 2018). As Gervás noted, the unique qualities of what constitutes artistic creativity go beyond the new, the beautiful, the interesting and the pleasurable – they reflect and appeal to an essential human quality: "A sunset may generate a totally new combination of colors, possibly unexpected, but it would not be considered creative." (2009, p. 49)

Creativity and Neoliberalism

As noted earlier, Mould's work raises the possibility that there is a neoliberal bias in current meanings of creativity. Alongside Stefan Kratke (2010) and Thomas Osborne (2003, see further reading), Mould has posited that the rhetoric of neoliberal creativity overshadows more diverse thinking about political agency, social infrastructure and value, and disguises the way capitalism absorbs all competing ideas into the neoliberal frame. Mould uses the example of a Pepsi advertisement featuring Kendall Jenner, which appropriated protest movements such as Black Lives Matter into a celebrity-driven corporate selling strategy.

The dominance of neoliberal ideas in creativity can also be seen in *Forbes* magazine's 2018 article discussing the "innovation capital" of the world's most creative and genius leaders, including Jeff Bezos of Amazon, Mark Zuckerberg of Facebook and Tim Cook of Apple (Allen, 2018). Each of these business executives has influenced the world by providing consumers with extraordinarily novel and useful products or services that make use of complex amalgams of data and algorithm permutations. Their innovations enable creative people and new forms of creativity (such as photography using iPhones), but while they excel in driving economic activity, negative impacts such as the diminution of privacy and teenagers' exposure to peer pressure and bullying (Child Law Practice, 2013) have been felt.

Tomas Chamorro-Premuzic has suggested that internet-centred economics and digital modes of human interaction have facilitated "a glut of unoriginal and trivial content", augmented people's self-perceived creativity and even 'killed' creativity (2015). Chamorro-Premuzic traces this to the use of emojis and other "pre-determined functions to express our views – liking, sharing, and, in some cases, disliking" which promote laziness and more consumption-based behavior. Thus, while technology has helped to democratize modes of communication and knowledge acquisition between classes, it has also created a society which is "horizontal, frictionless, decentered, heterogeneous and (as) networked as possible" for optimal consumption (Mould, 2018). The implication in these views is that technological creativity has begun to work in ways that restrict, control and dumb down human behavior, with too much data now sitting in the hands of technology leaders.

Dark Creativity and the Ethics of Artistic Creativity

One issue that sits at the center of art bias is creativity's tenuous relationship with 'the ethical'. Ideals of beauty, truth and edification in art prescribe a basically moral character to creativity, even though artistic work has also made significant contributions to destructive political and social systems. From sculpture to mosaic to metal-work to painting to theater, many works have aestheticized the lives of elite rulers and their military conquests (think of the Column of Trajan in Rome, 113 C.E. or the pyramids of Egypt) and underrepresented stories about people from lower-socio economic strata. Fairytales, a very different type of cultural production, have also widely propagated ideals of patriarchal domination and material wealth (O'Neill, 2018). A more extreme example of art's ability to cause harm is Leni Riefenstahl's celebrated film *Triumph of the Will* (1935) which glamorized the power of the Nazis in 1930s Germany. More recently, narrative and cinematic imagery in advertising have been crucial to the 'nudging' of human behavior toward certain patterns of consumption (Yeung, 2016, pp. 119–127).

As Arthur Cropley notes, referring specifically to the cases of Hitler and Stalin, it is still hard to value the 'novel effectiveness' of dark acts such as war and terrorism (McLaren, 1993) in the same terms granted to artists (2011, p. 141). Associations of creativity

¹The Victoria and Albert Museum's first computer art exhibition was titled *Cybernetic Serendipity*.

with art as a moral act endure, and many of the works which have survived throughout history (such as Greek plays and poems) show art to be capable of raising continually pertinent moral questions. Many theatrical works - both modern and ancient - provide a common space in which truths are contested and in which criticism is freely expressed. Modern fields such as arts psychotherapy have furthermore helped to heal, engage, motivate and fulfill vulnerable or outcast members of the community such as prisoners, abuse victims and refugees (Wadeson, 2010; see further reading). Research on children's education has shown that art facilitates many capacities required for learning such as "problem solving skills, creative thinking skills, evaluation skills, adaptation, assimilation, and association skills which are vital in a child's ability to apply the information that is taught in the classroom." Researchers emphasise that the positive emotional experience of creating and sharing art is critical for understanding others' emotions and communicating." (Scott, Boggan and Harper, 2011, p. 87).

While much of the art market is still operated by an exclusive intellectual class who trade works as luxury commodities (the global art bazaar rose to \$63.7 billion in 2017 from \$56.9 billion in 2016) other sectors of the traditional arts are falling from visibility. In 2017 more galleries closed than opened according to the Art Basel Report (Freeman, 2018; UBS [3AD]). Funding for the performing arts remains in steady decline in countries such as the US, the UK and Australia (Brisbane, 2015; Evans, 1999; National Endowment for the Arts, 2009) and experts note that arts organizations more broadly are struggling to perform like businesses to cope with the demands of neoliberalism.

Conclusion: Thinking About Art in an Expanded Field of Creativity Research

The diversification of creativity research since the 1950s arguably has introduced exciting and more democratic possibilities for thinking about novelty, innovation and human potential. James S. Fishkin's 'deliberative polling' for example has allowed citizens to engage more meaningfully on local and national issues (2017). Similarly, the introduction of microfinance for women in Bangladesh has fostered new and progressive social possibilities (Murshin and Murshid, 2018). Social media platforms have been at the vanguard of movements in societies previously trapped under limited political conditions. These and other examples demonstrate that it would indeed be significantly limiting in the present era, to think of creativity as only artistic.

Perplexingly, as creativity becomes more diverse and inclusive, 'levels' of creativity are declining according to research using Torrance tests. "Creative thinking is declining over time among Americans of all ages ... The decline begins in young children, which is especially concerning as it stunts abilities which are supposed to mature over a lifetime" (Kim, 2011, p. 293). Mueller et al.'s study on the workplace revealed an unexpected rejection of creativity, as some corporations appear to want more creativity but hold implicit biases against ideas which challenge more practical or unoriginal options (2012, p. 17). These results no doubt intersect with a range of social factors, but perhaps also point to the inherent and ongoing ambiguity surrounding the identification of creative potential.

The issue of arts bias is indicative of the present era. Difficulty lies in working out how to reconcile instinctive ethical and elite characterizations (grounded in art) with more utilitarian and productive, modern or destructive forms of creativity. The technology that drives neoliberal capitalism, and that tries to replicate the imaginative qualities of art, fits more closely with modern definitions - but some of it threatens to restrict and diminish future human creativity. Technology tends to reflect the wants and exigencies of a given era (Arendt, 1969, p. 167), whereas some art has sustained a permanence in human culture. For all its 'inutility' art often actively seeks to encourage the continual asking of ethical questions, and reminds us to second-guess new paradigms and systems of value.

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Introduction

A recent innovation in education, often called the STEAM movement, is predicated on the proposition that adding Arts to Science, Technology, Engineering, Mathematics and Medicine will improve STEMM learning and make future scientist and engineers more creative (NAS Report). The assumption behind the STEAM movement is that artists are more creative than scientists and therefore have something to teach STEMM professionals about how to be creative. Oddly, the equation is rarely considered in its commutative formulation, in which science and technology might be harnessed to stimulate artistic creativity. Historically, the science-to-art transfer is probably the more common direction in which interactions have occurred. This essay examines what characteristics arts and sciences share; what characteristics they do not; and why these things matter for understanding creativity in both sets of disciplines as well as for the hybrid practice of “art-science”.

Two Cultures?

There is little doubt that many artists have been scientists and many scientists, artists. One need only think of the archetypal Renaissance men, Leonardo da Vinci and Andreas Vesalius; the astronomer-composer William Herschel and Nicholas-Jacque Conté (the artist who invented of conte crayons as well as dozens of chemical and mechanical methods) and mathematician, philosopher, theologian, humanitarian Maria Gaetana Agnesi during the 18th century; Alexander Borodin, the composer and chemist and, biologist-artist-anthropologist Ernst Haeckel during the nineteenth; or mathematician-engineer-architect-composer Iannis Xenakis, MIT artist-mathematician Erik Demaine, and physicist-dancer-scifi-novelist-entrepreneur Catherine Asaro in the twentieth. Yet there have been persistent arguments for decades about whether such polymathic individuals were actually *combining* arts with sciences or simply practicing each separately. Perhaps geniuses are simply good at many things so that their multiple talents tell us nothing about whether the disciplines they practice have any cogent or coherent links (see POLYMATHS, this volume). For arts and sciences to meld into something that can be identified as an art/science hybrid, integration must be demonstrable.

Some eminent scholars have averred that the arts and sciences are so different as make such hybridization or synergy impossible. C. P. Snow, himself a very successful novelist, politician and physicist, famously characterized the arts-sciences divide in his 1959 Rede Lecture, *The Two Cultures*: “Literary intellectuals at one pole—at the other scientists, and as the most representative, the physical scientists. Between the two a gulf of mutual incomprehension—sometimes (particularly among the young) hostility and dislike, but most of all lack of understanding Two groups—comparable in intelligence, identical in race, not grossly different in social origin, earning about the same incomes, who had almost ceased to communicate at all ...” (Snow, 1959, 1–2).

The historian and philosopher of science Thomas Kuhn widened the divide a decade later by arguing that arts and sciences fundamentally differ in terms of their accumulation of knowledge. Whereas the sciences accumulate positive knowledge upon which each subsequent advance is made, and whereas the sciences have clearly stated paradigms defining legitimate problems, the appropriate techniques for investigating them and objective means of evaluating possible solutions, Kuhn argued that the arts use subjective forms of inspiration and evaluation that do not accumulate a growing body of knowledge or develop paradigmatic practices. While Kuhn further characterized revolutions in science as drivers of progress toward increasing understanding of nature, he characterized them in art as mere rejections of everything that had preceded (Kuhn, 1977).

Most recently, the embryologist and philosopher Lewis Wolpert has argued that no matter what superficial similarities may seem to link the arts and sciences, a closer look inevitably reveals that in terms of methods, results and utility, arts and sciences share nothing of substance (Wolpert, 2005). “Art has contributed zero to science, historically,” says Wolpert (Lythgoe, 2007). The participants of the 1980 Nobel Conference on *The Aesthetic Dimension of Science* (1982) had reached the same conclusion.

One difficulty that is often raised is that the products of arts and sciences are supposedly incommensurable. Arts are often characterized as being intuitive, subjective, sensual and unique; sciences as logical, objective, intellectual and universal. Consequently, some scholars have argued that if you give ten scientists the same problem, they will, if they succeed, produce identical results but if you give ten artists the same scene to paint and they will produce ten different pictures. Another supposed difference concerns the inevitability of scientific discovery and the uniqueness of the artistic vision. Nobel prizewinning physicist Werner Heisenberg reportedly said that had he not lived, someone else would have invented his indeterminacy theory but if Beethoven hadn't lived, we would never have the *Opus 111*.

If these positions were correct, then integrating arts and sciences is doomed to failure and there should exist no viable examples of hybrid art-sciences practices.

Domain Specificity Versus a Universal Creative Process

Various generalizations can be made about those who perceive the Two Cultures to be an accurate description of the relationship between arts and sciences and those who do not. To begin with, many of those who perceive an unbridgeable division work (or worked) in only one of these domains and have (or had) little or no training in the other. Notably, those who work (or have worked) in both domains almost universally describe them as being very similar. Ignorance, then, is a major barrier to communication across the Two Cultures, a point Snow himself made in his original essay on the topic.

A second division arises between those who focus on disciplinary products versus those who focus on creative process (Root-Bernstein, 1984a). Physicist Freeman Dyson has argued that, "The analogies between science and art are very good as long as you are talking about the creation and the performance. The creation is certainly very analogous." (Curtin, 1962, p. 139) Musician and composer Gunther Schuller, who was present for Dyson's remarks, responded, "Absolute similarities, just absolutely no difference," (Curtin, 1962, p. 142) Nobel prize-winning physicist Murray Gell-Mann (Physics, 1969) similarly asserted that, "Artists experience the same creative processes as scientists." (Weisburd, 1987, 299) He elaborated: "Everyone agrees on [where ideas come from]. We had a seminar here [at the Aspen Physics Center] ... including several painters, a poet, a couple of writers, and the physicists. Everybody agrees on how it works. All of these people, whether they're doing artistic work or scientific work, are trying to solve a problem." (Judson, 1980, 21) Only when the analytical focus is on the *products* of the arts and sciences do people generally assert that arts and sciences domains are irreconcilable; paintings or compositions are not only expressed in different symbol systems, media and materials than are scientific experiments or mathematical theorems but have different purposes.

A similar basis exists for the split among cognitive scientists between those who assert that creativity is domain-specific and those who believe that it is domain-general. Howard Gardner is an example of an investigator who has argued that people in different creative "domains" think differently and, more importantly, think in ways that mirror the types of things they produce. Gardner has defined about nine distinct types of intelligence according to whether each exists in isolated brain regions; is essential to mental function; is susceptible to specialized symbolic encoding or expression; can be developed in highly purified forms in prodigies, savants or other exceptional people; and is susceptible to psychometric or experimental identification (Gardner, 1983, 9). In his book, *Frames of Mind: The Theory of Multiple Intelligences* (1983), he initially identified seven such "intelligences" and identified each with a range of related professions: linguistic (e.g., poets and novelists); musical (musicians and composers); logico-mathematical (scientists and mathematicians); visuo-spatial (artists); bodily-kinesthetic (dancers); inter-personal (politicians, social workers); and intra-personal (psychologists). Subsequently, to account for biologists and farmers, Gardner tentatively suggested a "naturalist" intelligence; and for religious and philosophical thinkers an "existential" intelligence (Wikipedia, Theory of Multiple Intelligences). While admitting that eminent individuals may develop polymathic abilities in more than one intelligence [Gardner, 1983, pp. 7–10], Gardner's typology fundamentally draws absolute distinctions between how people in different disciplines such as the arts (visuo-spatial), dance (bodily-kinesthetic), creative writing (linguistic) and sciences (logico-mathematical and naturalistic) *think*. If such distinctions are as fundamental as Gardner originally drew them, then it is difficult, if not impossible, to imagine how arts (broadly conceived to include music, dance, creative writing, and visual and plastic arts) could inform the sciences, mathematics or technology, or vice-versa. Indeed, from Gardner's perspective, it would be a mistake to lump all the "arts" together in a single cognitive category, or to lump the various sciences such as biology and mathematics.

The Root-Bernsteins (1999) in their book *Sparks of Genius: The Thirteen Thinking Tools of the World's Most Creative People*, have responded to Gardner with the argument that, at a cognitive level, all creative people think similarly regardless of the discipline in which they perform their creative work. However, creative people choose to translate their insights into different forms and formalisms depending on the audiences with whom they are trying to communicate. Products of creative thinking are often generated by "intelligences" and using symbol systems and brain functions that are completely different than the ones used for their expression. Einstein, whose professional work was all expressed in words and equations, said, "No scientist thinks in equations." (Infeld, 1941, 312) "No really productive man works in such a paper fashion ... These thoughts did not come in any verbal formulation I very rarely think in words at all." Thoughts came, he elaborated, in visual and kinesthetic forms that he saw as reproducible dynamic images and muscular feelings: "A thought comes, and I may try to express it in words *afterwards*." (Wertheimer, 1959, 184)

Similarly, Martha Graham, one of Gardner's examples of a "bodily-kinesthetic" thinker, did not devise her dances through body thinking, but from reading, viewing paintings and listening to music: "I would put a typewriter on a little table on my bed, bolster myself with pillows, and write all night ... I get the ideas going. Then I write down, I copy out of any books that stimulate me at the

time many quotations and I keep it. And I put down the source." "I steal from the best where it happens to be – Plato, Picasso, Bertram Ross. I am a thief." Like Einstein, she then continued, "First there is the concept. Then there is the dramatization of that concept which makes it apparent to others." (Root-Bernstein and Root-Bernstein, 2003). One of Gardner's archetypal "linguistic" thinkers, T. S. Eliot, similarly wrote that his ideas did not originate in words, but in images and feelings and even music: "With a poem you can say, 'I got my feelings into words for myself. I now have the *equivalent* in words for that much of what I have felt.'" (Eliot, 1963, p. 104) Most creative people explicitly draw this distinction between modes of creative thinking and the need for a translation process that produces an equivalent of their insight in some defined medium (Root-Bernstein and Root-Bernstein, 2004). The creative product need not, then, reflect the creative process.

In contrast to Gardner, the Root-Bernsteins (1999) claim that all creative people rely on a common mental "toolkit" consisting of observing, imaging, abstracting, pattern recognition, pattern forming, analogizing, dimensional thinking, empathizing, body thinking, modeling, playing, transforming, and synthesizing. What differentiates disciplines is not different forms of thinking or different cognitive abilities, but rather differences in the constraints imposed on the products an individual creates by the tools, symbol systems, evaluation procedures, training and social norms that surround their production and dissemination. They reinterpret Gardner's findings concerning domain thinking as choices involving communication and dissemination of ideas and agree that most creative people master only a limited range of these, often only one. Thus, while the creative process and its cognitive bases may be common to people in all disciplines, the disciplinary knowledge required to *express* a creative insight is usually domain specific.

Moreover, neurological studies demonstrate that brain functions such as language, visuo-spatial ability, musical processing, and mathematical ability are often co-localized, undercutting another of the key discriminators that Gardner originally used to distinguish between "intelligences". Cognitive skills, perversely, appear to be both localized *and* distributed within the brain. Indeed, the study of synaesthesia suggests that every sensory and symbolic system is capable of both voluntary and involuntary mixing in every possible permutation (Cytowic, 1993). People can feel tastes, hear visual images, see and taste sound, perceive black-and-white symbols of any kind (words, math, music) in color, and so forth. From a neurological perspective, such synaesthetic combinations make possible any imaginable combination of arts, sciences, and technologies.

The fact is that many people who work across domains report that their thinking processes are similar or identical in all. Consider Georges Urbain, a synthetic chemist, the discoverer of the element lutetium, and a professional sculptor and composer. Urbain pointed out that chemists are as creative as composers and in the same way. All music is made up of a handful of notes combined in an almost infinite variety of combinations just as all of the physical world is made up of a handful of elements that make up every compound and mineral. Chemists and composers both explore the possible combinations in an attempt to discover novel and useful effects. Thus, "The musician combines sounds in the same way the chemist combines substances ... musician and chemist reason in their respective fields in the same way, despite the profound difference of the materials they use" (Urbain, 1924).

Similarly, MIT metallurgist Cyril Stanley Smith wrote that he often used what might be called "artistic" methods in his thinking and research because they complemented the usual "scientific" ones: "I have slowly come to realize that the analytic, quantitative approach I had been taught to regard as the only respectable one for a scientist is insufficient ... the richest aspects of any large and complicated system arise from factors that cannot be measured easily if at all. For these, the artist's approach, uncertain thought it inevitably is, seems to find and convey more meaning" (Smith, 1981, p. 9).

The physicist and sculptor Robert R. Wilson provides yet another example. He not only invented and designed the high-energy particle accelerators for FermiLab in Batavia, Illinois, but also the building in which it was housed, most of the sculptures that decorated its grounds and hallways, and even the utility poles providing the facility with its electrical power, commenting that: "In designing an accelerator, I proceed very much as I do in making a sculpture. I felt that just as a theory is beautiful, so, too, is a scientific instrument—or that it should be. The lines should be graceful, the volumes balanced. I hoped that the chain of accelerators, the experiments, too, and the utilities would all be strongly but simply expressed as objects of intrinsic beauty" (Wilson, 1992; np). Elsewhere, he elaborated: "If one thing is clear it is that there is much in common between what the creative artist does and what the scientist does" (Wilson, 1978; np).

Can Artists Make Scientific Discoveries or Invent New Technologies?

So, if the thought and creative processes of scientific discovery are very similar or identical to those of artistic creativity (broadly conceived as including creative writers, dancers, composers, musicians, and other performers), why do artists not make scientific discoveries and technological inventions? (see DISCOVERY, this volume; see POLYMATHY, this volume). Contrary to the opinions of Wolpert and the 1980 Nobel Conference cited above to the effect that artists have never contributed anything of substance to the sciences, these contributions are astonishingly numerous and important (Root-Bernstein, 2000).

Artists have discovered or invented perspective (the process of mapping a three-dimensional image onto a two-dimensional surface) and anamorphosis (the process of mapping any shape or image onto any other), which both have broad applications to mapping objects in cartography and in cinematography and, more surprisingly, to the biology of growth and form: D'Arcy Thompson employed anamorphosis to explain evolutionary relationships in his classic book, *On Growth and of Relative Growth Form* (1917) while Julian Huxley used it to explain fetal-to-adult developmental patterns in *Problems of Growth* (1932). Similarly, architect Buckminster Fuller's invention of geodesic domes had a direct influence on the discoveries of spherical virus structures and ultrastable spherical carbon compounds generically called "buckyballs", while sculptor Kenneth Snelson's invention of

tensegrity resulted in the innovations in the understanding of cellular architecture by Harvard's Don Ingber as well as a slew of engineering innovations such as the Kurilpa Bridge in Australia.

Artists are also responsible for inventing many optical puzzles and illusions such as Archimboldo's "faces" made out of bowls of fruit or stacks of books, "impossible figures" such as Escher's endless staircases, or Marcel Duchamp's "rotoreliefs", some of which appear to rotate in opposite directions simultaneously. These optical puzzles and illusions are often employed by modern experimental psychologists for investigating neurological and cognitive functions. Artists also invented diverse techniques for displaying motion ranging from zoetropes and kinetographs to motion pictures. Camouflage, both as a biological concept involving selection of organisms to mimic their environments, and as a technology for hiding soldiers and their equipment during war, was the brainchild of the painter Abbott Thayer. Another artist, Jonathan Kingdon, whose only degree is a Masters of Fine Arts, has revolutionized the study of evolutionary theory by producing hugely synthetic works integrating animal coloration, communication, and behavior with biogeography and paleontology – not incidentally, earning him a position as a Senior Research Associate in the Department of Zoology of Oxford University although his only degree is a Masters of Fine Arts. Yet another artist, Wallace Walker invented an entirely new realm of geometry called "kaleidocycles" as a design student at the Cranbrook Academy of Art, which he then collaborated with mathematician Doris Schattschneider to develop (Hagan, 1991).

Artists and musicians have also produced many inventions that we take for granted. Robert Fulton, who invented the steamboat, and Samuel Morse, the inventor of the telegraph, were two of the most widely acclaimed American painters before they turned to inventing. Their artistic methods are clearly evident in their invention processes as Brook Hindle has made clear in his book *Emulation and Invention* (1981). The first viable color photographic process, Kodachrome, was invented by a pair of professional musicians, Leopold Mannes and Leopold Godowsky. The wildly successful inventor James Dyson has only one advanced degree and that is a Master of Fine Arts. Actress Hedy Lamarr and composer-musician Georges Antheil invented frequency hopping, which is the basis for one of the most widely-used encryption algorithms for electronic communications currently in use by both commercial and military institutions. The invention of pointillist techniques by neo-Impressionist painters was the direct inspiration for the development of pixelization in electronic media. Programming was invented by weavers who invented punched cards to create tapestry designs on automated looms. In fact, modern electronic chips are made by means of three artistic techniques that long pre-date the electronic age: silk screen printing, etching, and photolithography. So common are such fundamental discoveries and inventions that the MIT-trained engineer-artist-musician Robert Mueller has written in his book, *The Science of Art* (1967), that, "Art may be a necessary condition for constructing the new consciousness from which future science gets its structural realities to match nature, in which case it is more important than we generally admit."

Paradigm Shifts and Multiple, Simultaneous Discovery in the Arts

The fact that artists can and do make scientific and technological contributions, often by using artistic and design methods, suggests that Kuhn and Heisenberg were incorrect to maintain that the arts produce unrepeatable variations without accumulating positive knowledge. Recall that one their basic arguments is that had Beethoven not written Opus 111, no one else would have; every artistic production is unique so that ten painters will produce ten different paintings, even when painting the same scene. The arts do not have the equivalent of paradigms and therefore do not progress.

The bases of Kuhn's and Heisenberg's reasoning can, however, be challenged. Is the Opus 111 more unique than Heisenberg's first paper stating the indeterminacy principle? Consider an example in which it is known that had not one scientist discovered a principle, someone else would have. Kuhn himself has pointed out in an essay in *The Essential Tension* (1977) that as many as fourteen different scientists had claims to have "discovered" the first law of thermodynamics. However, each scientist based that claim on a different set of observations and expressed the principle in a different formulation using unique data in an idiosyncratically written publication that, aside from a statement of conservation of energy, had little similarity to any of the others. So, when Heisenberg said that if he had not discovered the principle of indeterminacy, someone else would have, he was certainly not saying that someone else would have written *exactly the same paper* in exactly the same words. The fact that every painting or composition is unique is not something that differentiates arts from sciences: every scientific paper – and every mathematical proof – is also unique and exemplifies the particular style(s) of its author(s). Compare Charles Darwin's first essay on evolution by natural selection with that, published simultaneously and in the same journal, by Alfred Russell Wallace for a good illustration.

The differences between arts and sciences also disappear when comparisons are made not between individual works, but between *conceptual inventions* such as the first law of thermodynamics, the principle of indeterminacy, or the invention of the calculus and the invention of *movements* such as Impressionism, cubism, kinetic sculpture, polyphony or twelve-tone composition. Just as the sciences are characterized by simultaneous or multiple discoveries of the same principles and phenomena, so are the arts. Beethoven was not the only composer writing in his style, so if Beethoven hadn't lived, then we would recognize one of his contemporaries as the outstanding representative of "his" style. If not Mozart, then Salieri. Igor Stravinsky and Arnold Schoenberg spent most of the first half of the 20th century squabbling over which of them had invented twelve-tone musical composition and even recognized that its invention was inevitable: "Schönberg once told [Rosalyn Tureck] that if he had not developed 12-tone music, someone else would have, and that his work was a natural and historical extension of Mahler's" (Weisburd, 1987). Georges Braque and Pablo Picasso never agreed on which of them invented cubist painting. Kinetic sculptures were invented almost simultaneously in Italy by Giacomo Balla and Fortunato Depero, in Russia by Naum Gabo around 1915, and mobile sculptures simultaneously by Alexander Calder and George Rickey in the US, and Jean Tinguely in France, during the 1940s. Buckminster Fuller and

Kenneth Snelson never agreed on which one invented the sculptural principle of tensegrity. Claimants to the invention of electronic music include Lejaren Hiller, Jr., J. R. Pierce, Claude Shannon, and Max Matthews, Raymond Scott, Iannis Xenakis, and many other scientists and engineers who had musical training and access to the first computers during the 1950s. So, contrary to Kuhn and Heisenberg, there is just as much a logic of development from one artistic movement to another as there is a logic of development from one scientific innovation to the next. Artists of all types do build on the innovations of their predecessors just as scientists stand on the shoulders of their mentors (Root-Bernstein, 1984b).

Notably, the fact of simultaneous discoveries in both sciences and arts also addresses Kuhn's argument that arts do not have paradigms based on accumulated sets of problems and their corresponding methods, techniques and approaches to solutions. In fact, every new movement in the arts builds, as Schoenberg said, on previous methods and poses new problems that have not yet been addressed. Thus, the history of the arts is one of an ever-expanding set of tools for addressing ever-broader ranges of human experience and emotion (Root-Bernstein, 1984b).

Art/Sciences Intersections

Thus far I have mainly examined how the arts have influenced the sciences and technology, but it is equally the case that the sciences and technology have influenced the progress of the arts. So much has been written about the geometrical bases of perspective drawing and the scientific bases of color theory in the arts that some of these influences may seem obvious from a modern sensibility. However, many connections are less well-known, though equally pervasive and influential. For example, Louis XIV and his minister Colbert formally placed scientists into creative industries such as the Sevres china and Gobelins tapestry factories, helping to make France the world leader in the production of these products. One consequence of this strategy was that during the 19th century, the chemist M. E. Chevreul was assigned to help the Gobelins factory improve the colored yarns used in weaving its tapestries and discovered the artistic principle of color complementarity widely adopted by 19th and 20th century artists and designers. Indeed, scientists such as the Nobel Prizewinning chemist Wilhelm Ostwald and the physicist Ogden Rood were major developers of the color theories used by modern artists.

At around the same time, a huge shift occurred in paint manufacture. Through the middle of the 19th century, most artists made their own pigments and paints by grinding various natural materials into fine powders emulsified in oils or water. The invention of the paint tube permitted mass manufacturing of paints by industrial chemical firms and, not incidentally, permitted painters for the first time to explore *plein air* painting. Equally revolutionary was the invention aniline dyes at the end of the 19th century that introduced the first of many classes of synthetic pigments, greatly broadening the range of colors accessible to artists. Further artistic innovations followed close on the heels of computer visualization tools as well. Nobel Prizewinning physiologist Roger Guillemin was possibly the first individual to use a computer to produce art, helping to initiate the computer-art movement.

Equally revolutionary changes accompanied scientific and technological progress. The invention of the first electronic musical instruments began during the late 19th century as musically-trained scientists such as Nobel laureate Walther Nernst began to apply electricity to understanding sound production. Concurrently, music benefited from the scientific study of the differences between natural harmonic ("just" or "Helmholtz") tuning versus tempered scales by biophysicist Hermann von Helmholtz and Nobel laureate Max Planck. The chemist Lejaren Hiller was the first person to program a computer to generate its own musical compositions, helping to kickstart the electronic music revolution during the 1960s. Biophysicist Gerald Oster discovered the principles controlling the production and perception of aural binaural beats, which has since become a regular feature of electronic music compositions.

Less well-documented, but equally pervasive, has been the use of scientific and technological ways of thinking by artists. A few random examples: Some of Shakespeare's most memorable lines, such as "nothing will come of nothing," turn out to have been inspired by the recently invented zero (Tammiet, 2014, pp. 55–62). Emil Zola transformed the structure of the modern novel by attempting to recreate it in the form of the physiologist Claude Bernard's philosophy of positive science. The French sculptor Auguste Rodin wrote that, "I have come to realize that geometry is at the bottom of sentiment or rather that each expression of sentiment is made by a movement governed by geometry. Geometry is everywhere present in nature ... The entire rhythm of the body is governed by law." (Petersen, 2001, p. 9) 20th century Futurist sculpture and the invention of kinetic sculpture are equally imbued with technology and its principles; Surrealist painting, with the fourth dimension on the one hand and biological forms on the other; Cubism with relativity theory.

These examples demonstrate that there is no fundamental difference between the creative thinking of the scientist, the artist, the composer, and the writer. Historian of technology Thomas Hughes has noted that, "the invention of machines, devices and processes by metaphorical thinking is similar to verbal creation, but the fascinating possibilities have not been much discussed, probably because persons interested in language are rarely interested in technology." Similarly, James McAllister and others find that the use of aesthetic criteria in the sciences, engineering, and the arts are virtually identical, and that the notion of beauty in science may be as essential as a motivation for discovery, and as a criterion for evaluating novel ideas, as it is in the arts (McAllister, 1996). "Artists and scientists alike need to employ both rational and intuitive approaches, adds [Nobel laureate Murray] Gell-Mann. 'Many problems transcend disciplines and demand a fusion of the two ways of perceiving.'" (Weisburd, 1987)

Burton and his colleagues, have formally studied transfer of skills and knowledge between arts and sciences and perhaps deserve the last word on the cognitive connections that link arts and sciences: "Arts learning, involving as it does the construction, interweaving, and interpretation of personal and socio-cultural meaning, calls upon a constellation of capacities and dispositions

that are layered and unified in the construction of paintings, drawings, poems, musical compositions, and dances. Many of these same competencies and dispositions are implicated in other subject domains where they coalesce in equally distinctive forms: mathematical, scientific, linguistic - in the organization of different kinds of meaning, insight, and understanding. What is critical is not that capacities and dispositions transfer, but that they are exercised broadly across different knowledge domains and that no subject has prior rights over any other subject. To diminish one is to diminish the possibility and promise of them all." (Burton et al., 2000, 255)

Formal Arts/Sciences Programs

For many of the reasons discussed above, formalized arts-sciences programs have evolved over the past couple of decades to take advantage of perceived benefits of the integrations of these sets of disciplines. The concept of STEAM, an integration of Arts into STEM education was mentioned in the introduction. Various people take credit for inventing the acronym including John Maeda, former President of the Rhode Island School of Design, which implemented a STEM-to STEAM program in 2008; Harvey White, co-founder of both Qualcomm Inc. and Leap Wireless International Inc., also laid claim to having invented the acronym about the same time; and Georgette Yakman, a graduate student at Virginia Polytechnic and State University used the acronym $ST\sum M$ in a paper that year. Such integration has found other labels as well. The U. S. National Science Foundation funds some programs in the STEAM area but was prohibited from adopting the STEAM acronym due to lobbying by agriculture professionals who wanted the A to stand for Agriculture, so NSF has allowed the acronym "SEAD" instead, which stands for Science Engineering Arts and Design (e.g., <https://sead.viz.tamu.edu>). The European Commission decided on STARTS, for Science, Technology and the ARTS, and offers prizes in collaboration with Ars Electronica in Linz, Austria (the premier arts-and-technology forum in the world), the BOZAR Center for Fine Arts in Brussels, Belgium and The Waag center for Technology and Society in Amsterdam, The Netherlands (<https://ec.europa.eu/digital-agenda/en/ict-art-starts-platform>; <https://www.starts.eu>; <https://ars.electronica.art>; <https://www.brusselsmuseums.be>; <https://waag.org/en/home>) Artist-inventor Todd Siler invented and trademarked the elided term "ArtScience" in 1994 (long before Harvard artist-biotechnologist David Edwards published a book of that title) building an educational program around it called "Think Like a Genius" (also trademarked). Various groups such as the SciArt Initiative in the US and the SciArt Organization in the UK have utilized some version of a sci-arts combination. Integrating arts, sciences and technologies has become a recognized movement among both practitioners and teachers of these disciplines.

One of the more pressing issues facing this movement is finding joint spaces in which to practice combined activities. Arts materials, facilities and lessons are generally easily accessible to anyone regardless of educational background, so that STEM professionals desiring to explore artistic methods and concepts generally have a low barrier to entry. Exceptions exist for technologically sophisticated arts such as glasswork, some types of ceramics, etc., but, in general, adding arts to STEM subjects and practices is less difficult than working in the opposite direction. Artists desiring to create art out of scientific materials (bioarts, chemarts, transmedia arts, electronic arts, etc.) often need access to a scientific laboratory, which is much more problematic at present and may present additional barriers such as technical and safety training, chemical-, tissue-, or animal-use approval, and so forth. Thus, at present, the number of stand-alone arts-sciences programs is very small with the most notable being Coalesce: Center for Biological Arts at the University of Buffalo (Paul Vanouse); SymbioticA, the Centre of Excellence in Biological Arts in the School of Anatomy and Human Biology at the University of Western Australia (Oron Catts); Open Labs at Science Gallery, Dublin, Ireland; MIT's Media Lab; The Laboratory at Harvard University and *La Laboratoire* in Paris (David Edwards); the ArtSci Lab at the University of Texas, Dallas (Roger Malina); and the Art and Science Laboratory in Sante Fe, New Mexico, (James Crutchfield). In Spain, the main driver of artscience integration is VIDA | Art and Artificial Life International Awards.

As with any inter- or trans-disciplinary undertaking, one of the challenges for people bridging arts and sciences is finding reputable places to publish novel findings. Specialized journals devoted to the intersections of arts and sciences have also evolved. The first and best-known is LEONARDO, the Journal of the International Society for Arts, Sciences and Technology, which was founded by kinetic artist and aeronautical engineer Frank Malina in Paris in 1968. More recent additions to the field include *SciArts Magazine*, *The Art and Science Journal*, *The STEAM Journal*, *The International Journal of Arts and Technology*, and *The Journal of the Society for Art and Science*. However, one of the major challenges that art-science integration faces is that the resulting products do not neatly fit existing means of display and dissemination so that novel hybrid platforms are being designed that exploit combinations of print, online access, holography, video and sound technologies in addition to integrated studio/laboratory and laboratory/gallery spaces.

The overarching purposes of art-science integration has been summarized by Robert Root-Bernstein, Adam Brown, Todd Siler and Kenneth Snelson in a LEONARDO editorial. Their main points are: "ArtScience involves understanding the human experience of nature through the synthesis of artistic and scientific modes of exploration and expression. ArtScience melds subjective, sensory, emotional, and personal understanding with objective, analytical, rational, public understanding. ArtScience embodies the convergence of artistic and scientific processes and skills, not from their products One who practices ArtScience is both an Artist and a Scientist simultaneously, and one who produces things that are both artistic and scientific simultaneously We must teach Art, Science, Technology, Engineering, and Mathematics as integrated disciplines, not separately The mission of ArtScience is the re-integration of all knowledge. The goal of ArtScience is to cultivate a New Renaissance." (Root-Bernstein et al., 2011)

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Associative Theory[☆]

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Glossary

Associative Theory An explanation of creative thinking as the process by which disparate elements come together in new combinations for a useful purpose.

Convergent Thinking The process of bringing together information focused on solving a problem, especially problems that have a single correct solution.

Divergent Thinking The process of generating a variety of associations to a word or solutions to a problem.

Incidental Learning Unplanned or unintentional learning in which ideas or relationships, previously seeming to be irrelevant, are later associated.

Historical Foundations

Associative theory holds that creative ideas occur when disparate elements come together to form a new idea or solution to a problem. There is a general consensus in the field today that having a broad search process that enables a variety of associations to occur helps creativity. The importance of broad associations in the creative process has been a central component of many theories of creativity, including associative theory, which will be reviewed in this chapter.

The associative theory of creativity explores the ways in which ideas or solutions to a problem might be generated and how those ideas are linked together in the mind. Historically, philosophers, scientists, and psychologists have pondered the importance of associations in the creative process. Associationism was first a philosophical idea asserting that mental processes operated by the association of one state with its successor states. British associationists including John Locke and David Hume maintained that this principle applied to all mental processes. Ideas were said to be associated in the mind according to certain laws including contiguity and resemblance. Ideas could therefore lead to further ideas; this served as the understanding of mental functioning in general.

Alexander Bain wrote of the idea of incubation, when new combinations of elements can sprout from that which is already in an individual's mind. Imagine ideas in a person's mind, free-floating and continuously bumping into each other and combining. Sometimes, ideas will combine in ways that are not new, useful, or of any particular interest; however, other combinations may

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be a unique or novel solution to a problem, and grab our attention, such that the idea becomes conscious and recognized as creative. Albert Einstein spoke of “psychical entities” which made up thoughts and how the combining of these entities was the “essential feature of productive thought.” Such perspectives on the importance of combining already existing elements in new ways can be viewed as the influential precursors to associative theory.

Mednick's Associative Theory

In 1962, Sarnoff Mednick published his associative theory of the creative process, stating that creative thinking was the process by which disparate elements come together in new combinations for a useful purpose. A creative solution to a problem comes about by bringing together multiple ideas which only when combined in a new way become useful as a viable solution. A combining of more remote elements is viewed as more creative than the combining of more similar items. For example, the Beijing National Stadium designed for the 2008 Summer Olympics, known colloquially as “the Bird’s Nest”, combined the traditional needs of a stadium with the model of a nest, thus bringing together two remote concepts into one creative product.

According to Mednick, a person can produce creative solutions through any of three processes: serendipity, similarity, or mediation. A creative solution stems from serendipity when associative elements are evoked by a person’s situation and are accidentally put together. Fortuitous discoveries, such as when US Navy engineer Richard T. James accidentally knocked a spring off his work table and invented the Slinky, are considered serendipitous. A creative solution might also be produced through similarity, such as when associative elements are evoked because of their similarity to another element, such as with words that rhyme. Lastly, creativity might arise from the process of mediation, in which associative elements are evoked through the mediation of a third common element. For example, a medical diagnosis might serve as the mediating link between multiple symptoms which might otherwise appear unrelated.

Components of Creative Associations

Mednick identified a variety of variables that could contribute to the likelihood of someone coming to a creative solution or making a novel association, with a strong focus on individual differences: (1) the need for associative elements, (2) an individual’s associative hierarchy, (3) the number of associations one makes, (4) the influence of cognitive and personality styles, and (5) the process of selecting a creative combination. Each is discussed below in more detail.

The Need for Associative Elements

To make novel associations between elements or ideas, one must have elements or ideas in mind with which to work. Simply put, one cannot put two things together if one does not have two things. As Mednick stated, “an architect who does not know of the existence of a new material can hardly be expected to use it creatively.” Moreover, the more associative elements to which one has access, the more permutations and combinations are possible. Thus, individual differences in experience, memory, knowledge, and verbal ability have the potential to affect one’s level of creativity depending on the task.

The Individual's Associative Hierarchy

The associative hierarchy depicts the ways in which different individuals will produce associations to a problem (see Fig. 1). For example, if asked, “how many ways can you think of to use a tire?”, most individuals begin by giving some common associations, such as: “put it on a car to drive” and “make a tire swing”. Those individuals with steep associative hierarchies then show a marked decline in their ability to keep thinking of ideas, while those with flatter hierarchies continue to produce ideas, some of which are more unlikely or uncommon, such as “use it as a snow tube for sledding” or “shred it as the footing for a playground”.

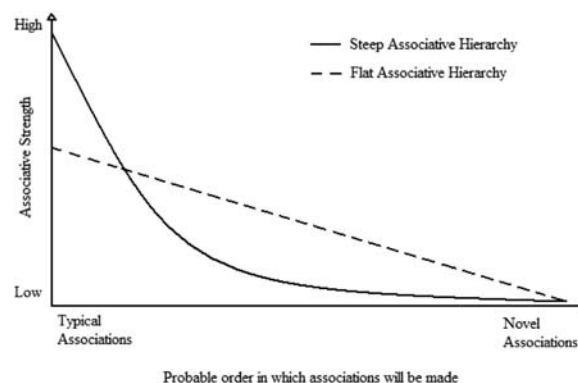


Figure 1 Possible associative hierarchies according to Mednick’s associative theory.

Mednick stated that the person with the flatter hierarchy can be said to be the more creative the individual, while the person with the steeper hierarchy is less creative. Not only does the person with the flat hierarchy produce more solutions in total, but also tends to produce more original solutions. This pattern of response generation for the more creative person, the person with the flatter hierarchy, is explained by postulating that in this creative person's mind, more ideas are connected, but the associations between the ideas are not as strong. This set up allows for a more interconnected mind, such that a given problem will lead to a wider range of solutions including those which are less common. In other words, word associations for the more creative individual will be less stereotyped. For example, a person with a steep hierarchy might respond to "table" with typical associations like "cloth" or "dinner", but then run out of associations, while a person with a flatter hierarchy might continue on to an answer such as "ping pong" or "water". For the creative individual, associations may be weaker but they are farther reaching.

The associative hierarchy leads to two important implications. First, a high concentration of associative strength in only a few responses can limit future creativity. For example, the greater the number of occasions on which a person has solved a problem using one particular solution, the less likely the individual will be to produce a creative solution in the future. Given the problem of a flat tire, and elements consisting of a spare tire and a wrench, who would generate possible solutions much beyond the tried and true response, "change the tire"? In other words, given the same problem, the same materials, and a solution that worked last time, one will have a steep associative hierarchy. This means that given the same problem and the same materials, an individual who is new to the scene or possesses less knowledge may be more likely to generate creative solutions than someone who has been presented with the same problem many times before.

Secondly, the hierarchy posits that most people, no matter the level of creativity, will begin by giving typical, unoriginal answers. Thus, it seems that novel associations are only produced after one has depleted their reservoir of more obvious ideas. This notion that the more creative ideas will come later in the associative process suggests that when an individual is faced with a problem, there is a benefit in taking enough time to get past the obvious solutions in order to reach those more remote connections.

The Number of Associations

The greater the number of associations an individual can produce for a given problem, the more likely their chances are of producing a creative solution. This notion is not completely separate from the associative hierarchy described previously. A person with a flat associative hierarchy is more likely to produce novel associations not only because of their weaker but broader associations in general, but also due to the sheer quantity of responses that they are more likely to generate. A possible explanation for this phenomenon, based on associative theory, is that the more associations that are made, the more likely it is that a link to a new associative element will be found, that will continue facilitating more associations. For example, a person naming animals may begin with unoriginal answers like "cat" and "dog", but once they think of "cow", they suddenly have a bridge to a host of other barnyard animals not yet listed.

The notion that it is usually only after the stereotyped responses have been depleted that more creative solutions are uncovered, is referred to as the serial-order effect - the tendency for the creative quality of ideas to increase over time. However, this is not always the case. [Beatty and Silvia \(2012\)](#) found that fluid intelligence moderated this effect, such that as fluid intelligence increased, the serial-order effect diminished, indicating that time was not necessary for more intelligent participants to produce creative ideas. The authors suggested that this effect could be explained by those participant's ability to inhibit salient but unoriginal ideas that typically come to mind at the beginning of the task.

Personality and Cognitive Styles

Given that a greater number of associative elements and number of associations produced are both likely to lead to more creative solutions, associative theory must also grapple with how an individual's previously learned methods for approaching a problem and their personality style in terms of persistence or motivation might influence their likelihood of producing creative solutions. Individuals who score higher on the personality trait of Openness to Experience, a dimension of the five-factor personality model referring to an individual's propensity to be open to new aesthetic, social, or intellectual encounters, are more creative. In a study of cryptic crosswords, [Friedlander and Fine \(2018\)](#) review how individual differences in openness to experience and sensitivity to external stimuli can impact the degree to which a person either inhibits or remains receptive to incidental information. Those who tend to pre-filter material they deem irrelevant may effectively reduce their likelihood of making lateral associations or accessing their associative networks.

Selecting a Creative Combination

What causes a person to pick one solution to a problem over another? Mednick's answer to this question reaches back to the definition of a creative product as something both novel and useful. The "usefulness" of a solution distinguishes a creative idea from a unique but random one. For example, when asked "How many ways can you use a tire?", it is implied in the question that solutions must include a tire and a way of using it. Therefore, answering "rubber" does not meet the "uses" requirements the way that "put it on a car to drive" does. However, using a tire on a car is far from a novel response. Conversely, while the answer "give it as an engagement ring" might be original (no other respondent provided this answer), it is not a realistic use for a tire, and therefore should not be considered as a truly creative solution.

Mednick asserted that the novel association or solution achieving the closest fit with the set of problem requirements is the solution which gets selected. For example, a diagnosis that is able to explain all of a patient's symptoms will be chosen over

a diagnosis that explains only half the patient's symptoms leaving the other half unexplained. The solution explaining all the patient's symptoms is the more useful. According to Mednick, the creativeness of a given solution can be seen as some function of the number of requirements that the product meets. A solution meeting all the requirements is more creative than a solution only meeting half.

Measures

The Remote Associates Test

An advantage of the clear predictions made by associative theory about individual differences and creative products is that they are testable. In 1967, Sarnoff Mednick and Martha Mednick operationalized associative theory's definition of creativity with the Remote Associates Test (RAT) (See [Remote Associates](#)). Since its inception, it has been used to test a variety of predictions about creative thinking and the problem-solving process.

The original RAT consisted of 30 items administered with a 40-min time limit. For each item the subject was presented with three words which seemed to be unrelated (playing, credit, report) and the subject was asked to produce a fourth word that would serve as the associative connection between the disparate words presented (card). The test items were intended to make the subject think creatively, by taking given associative elements and creating a novel combination by providing the mediating link. Mednick emphasized the importance that the links be strictly associative such that a subject must use creative thinking and not logic, concept-formation, or problem-solving to reach the same solution. A subject's score was calculated as simply the total number of correct answers out of 30.

Mednick reported the Remote Associates Test to have high reliability with samples of undergraduate males and females. Original validity studies found that high RAT scorers got good grades from teachers rated as flexible and low grades from teachers rated as dogmatic, and vice versa for those subjects with low RAT scores. Mednick also reported significant positive correlations between high creativity and social attitudes of liberalness. In follow-up papers, RAT scores were also found to correlate with the Creativity Rating Scale (CRS) on which professors were asked to rate the creativity of their graduate students. The RAT was not found to correlate with the Miller Analogy Test (MAT) nor with scores of GPA.

In addition to being a measure of individual ability, the RAT is a useful tool for studying the creative problem-solving process, particularly the concepts of insight, incubation effects, and fixedness on the wrong solution. Fixation on incorrect words can occur when an answer closely associated with one or two of the clues blocks access to more remotely associated words that are needed to reach the correct solution. Experiments by Nitin Gupta and colleagues showed that such fixation can be deliberately induced by priming subjects with commonplace associations that are unhelpful for reaching the solution. For example, for the RAT item Arm, Coal, Peach (answer: Pit), misleading associates such as arm-leg, coal-furnace, and peach-pear were presented as examples of potential associations, rendering the task more difficult. Consequently, test takers who can avoid a bias towards high-frequency potential answers and access more remote possibilities (i.e., those with what Mednick referred to as a flat associative hierarchy), will perform better on RAT puzzles.

However, critiques of the Remote Associates Test have also been prevalent. The test does not seem to take into account motivation or other intrinsic factors, including those which Mednick wrote about himself, such as past experience or the number of associative elements available which could also affect someone's apparent level of creativity. Later research found that an individual's ability to solve RAT items was significantly related to a variety of cognitive abilities, most notably verbal ability. [Daniel Fasko \(1999\)](#) has made similar arguments, citing research showing weaknesses in Mednick's original theory. For example, individual differences show that highly creative people tend to avoid repeating themselves more than less creative people. Fasko asserted that Mednick's associative theory may require some revisions to address the complexity of creativity.

Word Association

In a follow-up paper published in [1964](#), Mednick and colleagues continued to explore associative theory using a continual word association task. In this line of research, instead of looking at the associative hierarchy of an individual, the associative hierarchy of individual words were examined. The associative hierarchy of a word is defined by group word association norms. Thus, a word is said to have a steep associative hierarchy if it elicits only one dominant association and then many other associations all of low response strength. In contrast, a word is said to have a flat associative hierarchy if it does not elicit any single dominant response, but instead elicits many responses all of somewhat equal frequency. Studies of individual differences among words found that high frequency words elicited more responses than did low frequency words, and that nouns elicited more responses than did adjectives.

Research findings using both continual word association and the Remote Associates Test examining associative theory and the associative hierarchy notion has been mixed. Mednick's hypothesis was that highly creative individuals would respond relatively slowly but steadily, emitting many responses during continual word association. Instead, although the high RAT scorers did produce more responses, they also did so at a consistently more rapid pace than other groups and participant's level of creativity, as measured by the RAT, related directly to response frequency. Furthermore, when individual creativity was measured by divergent thinking and self-report, rather than by the RAT, associative hierarchies were not found to differ between the low- and high-creativity groups, but rather the high creativity people simply produced more answers and therefore more uncommon answers ([Benedek and Neubauer, 2013](#)). Results such as these suggest that the interpretation of creativity as merely associative behavior is too simple, suggesting the need for revisions to Mednick's original theory.

Other Measures

A wide variety of other association measures exist to further the understanding of associations in creativity. The Kent-Rosanoff Word Association test (KRWAT) is another word association measure. Participants respond to each stimulus word with the first word that comes to mind. The measure has shown significant correlations with other creativity ratings for engineering honor students and research scientists. This measure was the first to have objective scoring and norms presented in frequency tables; however, the test was criticized for not incorporating individual differences in responses due to factors such as socioeconomic status, age or education level.

Another related measure is [Gianotti et al. \(2001\)](#)'s word pair list, in which participants are shown a word pair that is either indirectly related (e.g. cat - cheese), or unrelated (e.g. corn - helmet). Participants are then asked to produce a third word that could serve as the connective link. In a modified administration of this task, participants were asked to judge the associative distance between the given words on a rating scale from 1 (strongly related) to 6 (without any relation), and complete several other creativity tasks. In support of Mednick's theory of individual differences in associative hierarchies, participants with higher creativity scores estimated the distance between the unrelated word pairs to be smaller than less creative people ([Rossmann and Fink, 2010](#)).

Semantic distance between responses can also be assessed using latent semantic analysis (LSA) in which software is used to determine the probability of a given word occurring in a specific context and assigning a coefficient of semantic similarity. This process can be used to measure individual differences in associative abilities by calculating semantic distance of responses generated during verbal fluency tasks, such as listing synonyms for the word *hot*. Those individuals with larger semantic distance scores would be considered individuals flatter associative hierarchies. Studies using LSA found support for the effects of associative abilities on the creative quality of divergent thinking responses.

One important development is that tasks such as the Remote Associates Test are now seen as involving some divergent thinking while individuals scan for broad associations, but are largely focused on convergent thinking, where information is brought together to form a single, correct solution. Insight tasks would also fit this category of convergent thinking. In contrast, creativity and creative potential are increasingly measured using divergent thinking tests in which subjects are asked to generate as many responses as they can think of. Divergent thinking tests are therefore more open-ended than the RAT, but serve as another way to explore individuals ideational patterns. Aside from the sheer number of ideas presented by a person (fluency), the individual answers might also be scored in terms of their flexibility, originality, or elaboration. Current measures used in this area include J.P. Guilford's Alternate Uses Task, Michael Wallach and Nathan Kogan's adaptation of the Alternate Uses Test for children, and the Torrance Tests of Creative Thinking (TTCT). How well a person performs on divergent thinking tasks was related to their self-reported creative achievement and expert ratings of creative performance, as well as predicting creative accomplishments.

Recent research found that associative abilities (i.e., high dissociation and associative combination ability) predicted half the variance in divergent thinking performance; such findings support the notion that in addition to being able to access remote associations, one must be able to combine them in adequate ways ([Benedek et al., 2012](#)).

Incidental Learning

In his 1967 paper on incidental learning, Patrick Laughlin suggested that the process of forming, retaining, and using remote associations is essential in both creativity and incidental learning. Laughlin defined incidental learning as a situation in which apparently irrelevant ideas or relationships are later be associated with each other. Based on associative theory, it is therefore predicted that a more creative individual will display better incidental learning.

Two possible factors are hypothesized to explain the connection between creativity and incidental learning. First, Laughlin suggested that a highly creative person might have greater perceptual sensitivity to the seemingly irrelevant stimulation presented in an incidental learning scenario. Secondly, it is also possible that the highly creative person is better able to retain the stimuli from the scenario in a more accessible form in order to use the information later for solving the incidental learning task. This notion seems closely linked to Mednick's ideas about the availability of information previously stored. In line with associative theory, Laughlin's incidental learning study results were interpreted as "reflecting wider deployment of attention and less screening out of irrelevant past experiences by high creatives during problem solving."

Neuroscience Approaches

Recent findings from neuroimaging research (fMRI) have identified the default mode network (DMN) as the brain system involved in spontaneous, self-generated thought. [Beaty et al., \(2016\)](#) concluded that this is the neurological network involved in mind wandering and letting one's thoughts roam. It is involved in the incubation stage of creativity where remote associations can occur.

Beaty and colleagues also identified a different network, the executive control network, that is involved in the evaluative, editing stage of creative tasks. The executive control network brings cognitive control and critical thinking to creative tasks. The RAT has a large component of evaluative thinking in reaching the correct word. Divergent thinking tasks involve both types of networks: an open-ended phase of idea generation and an evaluation phase that identifies solutions. Recent fMRI studies have found

a dynamic coupling between the DMN and executive control network when people engage in creative activities. Creative people can go back and forth between these two networks more easily than less creative individuals. Interestingly, these recent findings are consistent with early psychoanalytic theories based upon observation of creative individuals.

Psychodynamic Perspectives on Associative Theory

Classic psychoanalytic theory adds another perspective to understanding associations and creativity. In essence, individual differences in comfort with primary process ideation accounts for the number and originality of associations. Primary process thinking is, according to Robert Holt, drive-laden oral, aggressive, and libidinal content and illogical thinking related to that content. It is a developmentally early, primitive system of thought, heavily affect-laden, and not subject to logic. Sigmund Freud thought that if individuals repressed “dangerous” thoughts and wishes, then there would be a general intellectual restriction. In a primary process mode of thinking, ideas are easily interchangeable and attention is widely and flexibly distributed. Therefore, there should be a broader search for associations for individuals comfortable with primary process ideation. There is strong empirical support for this hypothesis on various divergent thinking and association tasks, especially with male participants.

The psychodynamic perspective is consistent with Mednick’s associative theory. It provides one explanation for why some individuals have such a steep associative hierarchy while others have flat hierarchies: there is a looser connection among ideas for individuals who have easier access to primary process thinking. There is not such a strong bond among ideas and images so that more flexibility-of-thought and associations can occur.

For true creative production to occur, individuals must go back and forth between primary process thinking and more logical thinking (secondary process thinking). This ability to access primary process in a controlled fashion is Ernst Kris’s concept of “regression in the service of the ego”. Because production of a novel and useful product requires original associations and evaluation, both broad associations and critical thinking are necessary. The RAT actually measures both of these processes. As previously mentioned, the RAT is not a pure association task. It has been categorized as closer to an insight task because it requires broad associations but then has one correct answer that must be selected. In psychodynamic terms, one must access primary process thinking and then use critical evaluation to select the right response. Creative production is, at least, a two stage process.

In an attempt to test this assumption, [James Murray and Sandra Russ \(1981\)](#) used the RAT with college students, along with the Rorschach, scored using Holt’s well-validated primary process measure. The Adaptive Regression score on the Rorschach reflects both primary process content and the control of that content. This score significantly related to the RAT for the total sample and more strongly in the male participants ($r = 0.42$), independent on SAT scores. In addition, Adaptive Regression related to the RAT more strongly than to measures of divergent thinking. Murray and Russ concluded from this study that a two-stage process accounted for the cognitive operations underlying adaptive regression and the Remote Associates Test. The first stage was a generative stage while the second stage was an evaluative stage. These findings are consistent with the neuroimaging studies described above.

Mood and Associations

Affect and mood are important variables in influencing the range of associations a person makes. Dimensions of affect account for individual differences in range of associations but also can increase the frequency and originality of associations when manipulated. Much of the research in this area has used a mood induction paradigm. For example, a specific mood is induced by having individuals watch a movie, receive a gift, or think of a memory. In a series of well-designed studies, Alice Isen and her colleagues found that positive affect induction resulted in increased creativity when compared with control groups. She concluded that the positive affect cues positive memories and a large amount of related cognitive and affective content. This process results in defocused attention and a more complex cognitive context, which, in turn, leads to a greater range of associations and interpretations. In another study, Isen found that positive affect improved performance on the RAT, while results for negative emotions were mixed. Interestingly, in one study, she found that induced positive affect resulted in a broader range of first associations to neutral words. They were more unusual and diverse than for individuals in control groups. This is different from what one would predict from Mednick’s theory that common associations would occur first for everyone.

A few studies suggest that mild forms of negative affect could facilitate some kinds of problem solving tasks. In a recent meta-analysis of 25 years of mood and creativity research, Matthijs Bass and colleagues concluded that positive moods do produce more creativity than neutral moods if the positive moods are activating (happiness) and associated with approach motivation. It should be noted that for the majority of studies, the connection with positive mood is for divergent thinking. In contrast, there is some evidence that positive mood may actually lower convergent thinking. Negative emotional states that might inhibit creativity on divergent thinking tasks may enhance performance on insight tasks for which there is a single, correct solution.

There are other current theories about why the involvement of affect broadens associations. Gordon Bower’s associative network theory conceptualizes emotion as a memory unit. The activation of the memory unit aids in retrieval of events associated with it and primes emotional themes for use in free association. In a model by Issac Getz and Todd Lubart, the emotional resonance model, endocepts that represent emotion are attached to concepts or images in memory. These emotional memories are partially interconnected and can activate one another.

Research has also begun to explore whether the perceived pleasantness of the task itself plays a role. Zenasni and Lubart (2011), found that the number of ideas generated on a divergent thinking tasks was significantly related to the perceived pleasantness of the task. Such research suggests that the impact of emotions in creative performance may not hold a single answer, but rather depend on many factors including the nature of the creative task itself. One important implication of the research on mood and creativity is that breadth of associations can be altered by the involvement of emotion. The steepness of an individual's associative hierarchy is likely influenced by affect.

Conclusion

One test of a theory is the impact that it has had on a field. Using that criterion, Mednick's associative theory and the psychodynamic theory of association has been useful. Through theory and research, these conceptualizations focused the field of creativity on the importance of associations in creative thinking. It is now generally accepted that creative production is partially dependent upon having a broad search process and novel associations. The RAT has proven to be a valid measure of a specific type of creative thinking and has been used in many studies of creativity in adults. Mednick, especially, provided an important foundation, in both his theory and his test, for other research programs and theories to develop. Although criticized as being simplistic in its view of the creative process, it made a major contribution to the field. Current research and theories continue to focus on the important process of association in generating creative ideas. Neuroimaging studies in particular may help identify the specific role of associations in different types of creativity tasks.

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Asynchronicity[☆]

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Glossary

Asynchronicity An appropriate level of discrepancy that may stimulate creative thinking.

Cognitive dissonance Inconsistent cognitions that do not fit together and which motivate creative thinking.

Janusian Thinking Cognition that uses two or more contradictory ideas simultaneously.

Person-environment fit Joint influences of individual and setting with similarity between the two is expected to nurture creativity.

Tension Inner conflicts experienced as a result of interpersonal or intrapersonal mismatches.

Introduction

A considerable amount of knowledge accumulated in the literature on creativity comes from studies of eminent people whose lives and achievements are taken as a proof of their creativity. Historiometric studies and research on socially recognized creativity have provided useful information that help understand the dynamics of creative achievement. Asynchronicity emerged from this line of investigation and is apparent in some eminently creative individuals. It helps to distinguish creativity from expertise, giftedness, genius, or prodigiousness. It is also critical for understanding the personal, environmental, and domain-related foundations of creativity.

The concept of asynchrony was first discussed in detail by Howard Gardner and Constance Wolf (1988), who made a case based on their analysis of Pablo Picasso and Sigmund Freud. Later, Howard Gardner extended his analyses to others such as Stravinsky, Eliot, Graham and Gandhi in his book *Creating Minds*. However, the effects of asynchronicity had also been noted by other researchers who used synonyms such as tension, conflict, disequilibrium, or dissonance. This chapter attempts to show how the construct of asynchronicity has been interpreted in the field and how it relates to those other processes and to creativity.

Asynchrony refers to an appropriate level of disharmony or discrepancy that helps to stimulate creative thinking. Gardner and Wolf described how “strategic mismatches or asynchronies” may underlie creativity. They disagreed with the proposition that creativity is the “wake of the numerous interacting factors” and rather, contended that “creative efforts are more likely to arise when there is a certain tension or asynchrony among principal factors that underlie human behavior. It is this tension that gives rise to creative works” (p. 101). Asynchronicity or tension is not simply a situation that exists in creative people’s upbringing. In fact, creative individuals often seek it, whereas others tend to do the same for synchrony. Novelties, creations, and new perspectives may be possible for people with unusual or uneven profiles who can think outside the box and see the world in alternative ways.

[☆] *Change History*: September 2019. Selcuk Acar updated the text throughout the article.

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Three Levels of Asynchronicity

There are different kinds of asynchronicity including but not limited to conflicts with family members, homosexuality, early difficulties in school, irregularities in cognitive development, sickness and loneliness in childhood. Gardner classified potential sources of conflicts in three levels: personal, impersonal, and multipersonal.

Personal Level

Asynchrony on the personal level can operate in several ways. The first is actually a sub-personal aspect, which is about genetic, neurological, and brain-related differences residing in creative minds. Attempts to explain such differences such as analysis of Einstein's brain after his death did not yield conclusive results or were abandoned later, as with the argument connecting creativity strongly with right brain function. Contemporary research underlines the importance of a whole-brain approach such as cooperation of default and executive functions. Research on people with brain injury and the case of autistic savants who can spontaneously find prime numbers in spite of being unable to perform basic multiplication or reading shows that neurological and neuroscientific research promises an explanation of unusual minds. One commonly emphasized unusual characteristic related to brain function is the dominant hemisphere which, for the most part, refers to the left hemisphere taking over sequential, analytic and verbal process whereas nondominant hemisphere processes are attributed to right-brain action involving simultaneous, visuospatial or synthetic processes. This design is subject to change, even reversal, when the person is left-handed. The fact that most people are right-handed, and creative artists prefer using their left hand (Preti and Vellante, 2007) can be explained by this unusual hemispheric asymmetry.

Another aspect of asynchrony at the personal level involves cognitive capacities and structures of creative people. As Gardner discussed in detail, creative people may either have unsurpassed levels of particular intelligences, as was the case with Picasso, who had very high spatial and bodily-kinesthetic intelligence with exiguous scholastic intelligence, or may possess an unusual blend of intelligences like Freud, who apparently had superior logical, intrapersonal and linguistic-verbal intelligence. However, asynchrony sometimes also comes from thinking processes. Some research relating creativity to *primary process thinking*, which enables free association and thinking with metaphors and symbols, rather than *secondary process thinking*, which is logical and goal oriented, is critical to understanding the moment of inspiration and the concept of incubation. Here, asynchrony involves the function of primary process thinking, which is regarded as an indication of regression serving the ego, while secondary process thinking would represent synchrony among a set of logical thoughts and assumptions. Creative people may differ in that they utilize and balance their primary and secondary thinking processes whereas most people suppress their primary processes and overemphasize the secondary process with aging.

The role of unusual cognitive patterns in creativity can be extended in different ways. Albert Rothenberg asserted that the creative thinking process involves *Janusian thinking*, which was defined as "the capacity to conceive and utilize two or more opposite or contradictory ideas, concepts, or images simultaneously" (p. 11). He argued that Janusian thinking is basically secondary process thinking that modifies primary process thinking by providing its "seeming ubiquity" and allowing "primary-process-like material to appear in consciousness". He interviewed Nobel laureates from several fields and concluded that the Janusian process plays a significant role in scientific creativity. He identified four levels of process: 1) motivation to create; 2) deviation or separation; 3) simultaneous opposition or antithesis; 4) construction of the theory, discovery, or experiment. Opposing ideas that emerge at the second and third level are often resolved and disappear at the fourth stage. The transition from the third to the fourth stage includes a state of asynchronicity or tension: "Strong motivation provides the drive to consider and conceive the inconceivable; emotional involvement, especially if it involves meaningful conflict, jibes with the cognitive tendency to focus on opposites and antitheses and bring these together simultaneously. The simultaneous opposition and antithesis, with the conceptual conflict retained among composing elements, seems to be isomorphic with emotional conflicts and other psychological processes" (p. 221).

Another critical quality of many creative individuals is their preoccupation with diverse modes of thought simultaneously. Acar and Runco (2015) reviewed these and others who agreed with this perspective and applied it to scoring of divergent thinking tasks. Divergent thinking accompanied by evaluative thinking or imaginative cognition paired with realistic cognition would mostly result in creativity, although they may not achieve that independently (Basadur, 1995). Arthur Cropley (1996) argued that creativity is the consequence of the joint influence of divergent and convergent thinking, which are seen as opposing thinking modes. He supported this hypothesis with the case of Vincent van Gogh, whose artworks became well-known after he learned basic techniques of painting. His artistic potential, represented by divergent thinking, would not have been fruitful had he acquired convergent skills. Mark A. Runco (1994, 1999) added that even incompatibility between such diverse modes of thought might be useful when tension is triggered.

Some empirical studies can also be approached as documenting asynchronicity emerging at the cognitive level. Roni Reiter-Palmon et al. (1997) examined the influence of cue consistency on problem construction. They found that the quality and originality of the solutions were higher in the presence of inconsistent cues. Likewise, Ella Miron-Spektor and her colleagues (2011) found that people were more creative when they were exposed to contradictions. It is reasonable to argue that tension springing from inconsistent cues or contradictions might elicit creativity. According to Keith James et al. (1992), tension frequently functions as a signal that indicates a need to fix, modify or resolve on the perceiver's part.

The third aspect of asynchrony on the personal level is non-cognitive, which is more about personality and emotions. The creativity literature lists numerous personality characteristics of creative individuals that can be related to marginality such as childlike nature, daydreaming, playfulness, contrarianism and nonconformity. Each of those characteristics can be seen as sources of

asynchronicity. Einstein is a remarkable case for the role of personality in creativity. Gardner argued that Einstein preserved his childlike nature and naïvety even as an adult, and this enabled him to approach problems in a different manner from others. In this way, he was able to ask the critical questions the answers to which he could find later. For example, the question “Why is the sky blue?” would be a childhood curiosity for many who later quit thinking of this question without searching for any answers. What makes Einstein and few others different is their unending interest in such basic yet significant questions that would lead to many scientific elaborations.

W. Ed McMullan (1976) argued that many creative people have “paradoxical personages” by which he referred to the coexistence of eight polarities in their personalities. First, most creative people tend to delay closure and are open to new ideas while at the same time they feel a strong urge to achieve closure and eventually form a gestalt. Second, they are inclined to swing between the modes of lateral thinking and logical thinking. Third, they can also merge the unconscious into consciousness which allows them to keep up “mindless perception”. Fourth, creative people are often fault finders and destructives, but they also reconstruct and make new syntheses. Fifth, they mostly have passion, but they also need to stay calm and reasonable. Sixth, they are both ego-centered and empathetic since they desire success, power, fame, and honor, yet are also altruistic, concerned about others and their well-being. Seventh, they are usually confident about their abilities and proud of their successes while they are humble and aware of their weakness and ignorance for the most part. Last, their insight emerges when they are in a state of relaxed attention, which is the moment of shift between work and relaxation. Likewise, Mihalyi Csikszentmihalyi (1996) discussed the complex personality of creative people as an integration of contradictory extremes. He argued that creative people are usually both energetic and quiet, smart and naïve, disciplined and playful, imaginative and realistic, extroverted and introverted, humble and proud, masculine and feminine, rebellious and traditional, passionate and objective, and suffering and joyful.

As for emotions, relationships with the opposite sex are mostly exploitive and temporary. In such cases, broken relationships were sometimes followed by suicides. As Arnold Ludwig (1995) showed in his search for the “Price of Greatness”, higher rates of suicide among members of the sample with exceptional creative achievement was one of the costs that some of them encountered. Also, several studies including meta-analyses (Baas et al., 2008; Davis, 2009) indicating a relationship between mood disorders and creativity can be looked at within the realm of personal non-cognitive asynchronicity. The frequent association of creativity with mental illnesses, specifically mood disorders, should be recalled here. Nancy Andreasen found that 80% of creative writers experienced a mood disorder like depression, mania or hypomania at least once in their lives.

Impersonal Level

The second level of asynchrony involves the domain of knowledge, the impersonal level, where creative individuals need to interact. Knowing about the domain is a necessity for contributing to or challenging it. Robert J. Sternberg views creativity as a process of “defying the crowd” where the creator resist against the pressure for compliance and conformity. There was no cubism, psychoanalysis or physics of special relativity before Picasso, Freud and Einstein learned about, influenced, mastered and evolved the domains, and eventually created their own domains. If they had been in complete agreement with their domains, they would not have revolutionized those domains. Therefore, discontent or dissatisfaction with the domain is oftentimes fruitful and can initiate epistemological changes in that field. A good example of this is Freud, who began with philosophy and switched to scientific medicine. Going through neurology, neuroanatomy and psychiatry, he came up with a new domain, psychoanalysis, which influenced many other domains from visual arts to political science.

Knowing a domain is a crucial aspect of creativity because learning process brings recognition of the gaps and inconsistencies regarding the content. Scientific creativity has a lot to do with the domain. In the sciences, many contributions arise from those gaps and inconsistencies in the domain. In physics, for example, Newton’s physics represented the core of the domain for a long time, and Einstein acknowledged that “The whole development of our ideas concerning natural phenomena [...] may be conceived as an organic development of Newton’s thought” in the article in which he discussed the limitations and weaknesses of Newtonian physics. However, creativity more than simply an outcome of extensive knowledge acquisition in a particular field. It is an important, but not sufficient condition. It takes one who mastered a field to challenge the knowledge base and redefine the domain (Kaufman and Kaufman, 2007).

Multipersonal Level

The third level of asynchronicity is the perspective of the field, which is the multipersonal level. Creativity does not come out of a vacuum. There may have been many creative ideas that remained unrecognized because the people who evaluated the work did not find them impressive and valuable. Such lack of fit between the creative person and the field might result in a fruitful asynchrony in cases which the creative people could resist the forces of the field and launched their own influence in spite of the price such as being alone like Freud. Mihalyi Csikszentmihalyi mentioned E. O. Wilson and presented his works as an example of attempts to construct a new domain called Sociobiology, connecting social sciences with evolutionary biology. Just like the examples above, he had severe disagreements with people within field. Another example of asynchrony at the multipersonal level is Hilde Domin, who is a famous poet and writer. She had to wait for six years to publish her poems because of the politics of the field. Her naïvety and lack of knowledge about a “literary mafia” helped her to sustain and have an independent literary career. This is why some people’s creativity is only recognized posthumously (Ludwig, 1995).

Dichotomous Classification

The asynchronicities exemplified above are simply based on Csikszentmihalyi's systems approach involving the interactive or dialectical relationship of the three elements: person, domain and field. Mark A. Runco preferred *tension* to represent the construct, and classified asynchronicities in two groups: intrapersonal and interpersonal. With this categorization, Runco related the personal level to intrapersonal tension that implies a misfit between the situation and its perception by the individual, or to inconsistent thoughts that associate the field and domain with interpersonal tension.

Intrapersonal tensions are crucial for creativity. Csikszentmihalyi used the term *cathartic originality* to describe the underlying processes of artworks. He argued that the discomforts that are rooted in repressed tensions of childhood may stimulate creative works after the individual becomes mature and better able to handle them. Unsurprisingly, psychoanalytic views on creativity have supported this argument. William G. Neiderland reported that psychoanalysts encounter common factors such as tragic early childhood experiences, traumatization and conflicts, loneliness, loss, and discontent with body image among creative people in their clinical experiences. Many creative people's response to such unfortunate experiences is a heightened emotional reactivity that evokes their awareness of already existing oversensitivity to internal and external stimuli. The feelings of being incomplete, ugly and deficient among creatively active individuals are often replaced by sensations of completeness, adequacy and strength through artworks. Martin S. Lindauer explained the stylistic changes of artists in the same way. Personal conflicts like physical or emotional handicaps are sometimes compensated for through artworks. The presence of grief, ordeal, pain and irregularities in biographies of some creative people confirm this notion.

In the intrapersonal case, further elaborations can be made. For instance, Leon Festinger called tension arising from two or more inconsistent cognitions *cognitive dissonance*. According to him, it is human nature to sustain an internal consistency among opinions and attitudes. This consistency is a state of consonance and equilibrium in which individuals are free of tension. With the emergence of new situations or the acquisition of new knowledge, existing cognitions are challenged, and individuals are motivated to reduce the dissonance and achieve consonance again. Therefore, the presence of dissonance functions as an antecedent condition that stimulates human cognition to a new synthesis. This is how cognitive dissonance may result in creative thinking. Colin Martindale hypothesized that creativity is related to resistance to cognitive dissonance in the sense that creative people, unlike most others, may not be motivated to achieve consonance. The more people tolerate novelty and deal well with incongruity and respond to it in a flexible way, the more they experience dissonance, taking advantage of it, and eventually, the more creative they become.

Is this the case in real life? Edward Boring, who wrote "Cognitive Dissonance: Its Use in Science", argued that "Any reader of Kepler's biography will wonder how the three great planetary laws could have emerged from so in consonant a mind, in which mysticism was mixed up with a passion for accurate observation, which perceived as one of its great intellectual achievements the spacing of the six planets in the solar system as related to the shape of the five regular geometrical solids, a mind which took astrology seriously, and which experienced ecstasy over both its true and false successes" (p. 683).

Cognitive dissonance theory makes it possible for creativity researchers to see the link between intrinsic motivation and creativity, given that Festinger regarded cognitive dissonance theory as fundamentally motivational. Since dissonance is discomforting, so it oftentimes functions as a source of arousal. The dissonance provides most people with a directional goal in terms of which they can either search for memories to support the desired conclusions or search out new knowledge to create a new explanation. The latter is actually how cognitive dissonance leads to the motivated reasoning resulting in creativity.

According to Jean Piaget, intrinsic motivation is preceded by certain cognitive operations. This occurs when individuals encounter new knowledge that they cannot understand. In this case, new ideas are not compatible with current conceptions, and disequilibrium emerges and continues until the individual assimilates or accommodates to reach equilibrium again. At that point, it is critical to point out that creativity is achieved as long as individuals can adapt to new information and expose themselves to perennial conflicts, even as they grow older. Morris I. Stein also acknowledged the role of disequilibrium claiming that it takes place at the beginning of the creative process.

Another kind of asynchrony is related to cortical arousal. Colin Martindale argued that the arousal system of creative people is unusual. He observed that their arousal level does not linearly increase with the arousal potential of the stimuli. At some point, there is a "dip" in their arousal, which seems to correspond to the moment of inspiration, unlike uncreative people, whose cortical arousal increases with the arousal potential of the stimulus. He showed that the EEG activity of creative people was lower during the inspiration phase than uncreative people whereas there was not any difference in the elaboration phase. He linked lower level of arousal with the unfocused attention that enables elaboration of several mental elements simultaneously.

Asynchronicities at the interpersonal level may occur in the family environment, too. Robert S. Albert and Mark A. Runco argued that incongruent parent-child relations can create tension, which enables the child to develop autonomy. Richard Koestner and his colleagues (1999) found that parental conflicts in the form of disagreements, rather than warm and liberal parenting, predicted adult creativity. From a factual standpoint, loose relationships of eminent physical and biological scientists with their parents as well as findings regarding the high rates of parental loss in the exceptionally gifted population seem to support this hypothesis. Sibling rivalry, family size, birth order and parental expectations are important factors to be considered as potential sources of asynchronicity at the interpersonal level.

Cultural marginality could also be mentioned under the umbrella of the interpersonal level. According to Thorstein Veblen, the intellectual success of the Jews in Europe is related to their cultural marginality. In Freud's case, he had to leave Austria because of

Nazi oppression. Before his life in France, Picasso lived in Spain and kept his ties with his native country. According to Csikszentmihalyi, a distinguishing feature of the centers of creativity throughout history was that they were at the crossroads of cultures and cosmopolitan life in those cities where diversity of thought and lifestyle is the rule rather than exception.

Asynchronicity Versus Person-Environment Fit

A frequently mentioned factor involved in creativity is the rule of “being in the right time and right place,” which refers to a good match of the person with familial, social, economical, political, or cultural surroundings. According to this view, the concurrent presence of these advantages paves the way for creativity. Creativity is defined as the outcome of the individual’s behavior in a context. Therefore, the joint contribution of person and environment should be taken into consideration. To exemplify this, a non-conformist individual within an environment that encourages or tolerates non-conformity would be a good match for creativity. However, the asynchronicity approach seems to disagree with the idea of person-environment fit.

According to asynchronicity, the coming together of several positive factors or coincidences may explain the emergence of prodigiousness or eminence, but not creativity. For this reason, the rule of “being in the right time and right place” works in the opposite manner for creative people: for creativity to emerge at least to some degree, the right time and place implies a context that brings somewhat lack of fit or disharmony. According to [Runco and Gaynor \(1993\)](#), the matching should be optimized so that an appropriate level of discrepancy for creativity is maintained. For this reason, Simonton described the best mentors as those who fall between the “too similar” and “too dissimilar” ends. Daniel Rubenson and Runco also argued that an optimal mix of individuals is necessary for creative productivity. This also means that too much as well as too little asynchronicity is mostly unproductive.

Unproductive Asynchronicity

In their discussion of the concept of asynchronicity, Gardner and Wolf asked the following question: “When does asynchronicity become counterproductive?” This question was legitimate, given research findings associating creativity with madness. Recent meta-analytic investigations by [Selcuk Acar and his colleagues \(2018\)](#) on the relationship between certain psychopathologies and creativity provided support for an inverted-U-shape relationship between the two. Runco admitted the interpretive nature of tension that makes it hard to generalize, and responded to Gardner with “more is not necessarily better”. According to him, even the optima may not be optimal at certain times. While some amount of asynchrony motivates, it may be inhibiting when it becomes excessive. Ideally, it is best when “the tension is distributed such that the individual is not overwhelmed by one experience, nor from accumulation of disturbance and depletion of resources” (p. 188). Briefly, the optimum level of asynchrony is the situation where individuals are challenged but can adapt and grow. According to Michael Rutter, the optima depend not only on the amount of tension but also on the way individuals react to it. The cognitive capacity of individuals determines how much tension with which they can successfully cope.

Such generalizations may fail in certain cases. Keith James found that originality is improved when people perceive conflicts in the domains on which they focus. Howard E. Gruber went further and argued that the association of tension with fields ranging from sciences to arts differs. He suggested that sciences are linked with interpersonal tension while arts are related to intrapersonal tension. As a result, there may be domain-dependency in the optimal level of tension. Csikszentmihalyi described the optimum level of asynchronicity between the person and the fields as follows: “The creative individual must reject the wisdom of the field, yet she must also incorporate its standards into a strict self-criticism. And for this one must learn to achieve the dialectical tension between involvement and detachment that is so characteristic of every creative person”.

The inverted-U-shape relationship between creativity and asynchronicity has been explained in several ways. According to Martindale, the optimal performance occurs at the moderate level of cortical arousal. James A. Easterbrook proposed that this relationship is mediated by task complexity: higher levels of arousal are efficient for simple tasks but not for complex tasks. Task performance decreases in low or high arousal levels compared to the optimal level because of the presence of irrelevant cues or lack of several cues, respectively. The optimal performance should be expected when individuals have several cues that can be used for a novel and original idea.

In a study on the comparison of the high versus low creative people with respect to anxiety and defense mechanisms employed, Ingegerd Carlsson found that the high-creative group had more anxiety than the low-creative group. She reported that mild and moderate signs of anxiety are found “almost exclusively” among the high-creative group as measured by meta-contrast technique. If we consider anxiety as a possible sign of asynchronicity at the personal non-cognitive level, those findings confirm an inverted-U-shape relationship between asynchronicity and creativity. An example of unproductive asynchronicity in organizations is intensified interpersonal conflicts. Although some level of conflict helps new ideas and syntheses to emerge, too much conflict undermines a positive working environment, resulting in rumors, gossip, and destructive competition.

Asynchronicity in Practice

Education

If asynchronicity is essential for creativity, can we create asynchrony to stimulate and enhance creativity? According to Piaget, children do not show interest in any stimuli if it is far above their cognitive level or when it is a routine task. The ideal situation is the presentation of stimuli that is somewhat challenging but graspable for a child. This level of discrepancy was contended by Lev S. Vygotsky (1978), who introduced the concept of the *zone of proximal development*, defined as “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers” (p. 86). Creative potential of children can be maximized through challenges that fall within the zone of proximal development. According to Runco and Radio, one critical factor for parents and teachers is their recognition of creativity in children because providing environments that support creativity is only possible if they believe that the children possess it at some level. Once they have a realistic perspective about the creativity of their children, they can regulate their expectations. They described this as *scaffolding*.

Apparently, the view of asynchronicity has solid bases in education. Contrary to frequently suggested approaches such as unconditional positive regard, which refers to acceptance of the ideas without any critiques, asynchronicity offers to confront the individual with the defects and drawbacks of the creative products and encourages showing some ways to improve creativity at the creator's pace. However, it may become unproductive depending on the children's perceptions. Instructional activities can be designed in a way that students experience tension. Teachers can point out, for example, the gaps and incomplete parts of the ideas and theories instead of merely providing the facts. According to E. Paul Torrance, tension is aroused when we sense the incompleteness or disharmony. This tension lasts until we come up with explanations or solutions resulting from long-lasting processes of trial-error, manipulation, guessing and testing. Having students notice and recognize the disharmony and incompleteness can be intriguing and curiosity-provoking.

Organizations

Asynchronicities are useful for organizational creativity, too. Indeed, Michael A. West argued that innovation and conflict are concomitant: “If a new way of doing things is introduced within an organization and no conflict is generated (that is, there are no disagreements about the content or process of the innovation), or if there is no resistance by organization members to the innovation, then this innovation is not really new nor does it offer a significant contribution to the organization. Innovations threaten the status quo and thereby produces conflict (p. 101)”

Various benefits of conflict and asynchronies have been found in studies of organizations and the workplaces. Lorraine Dugotino suggested that brainstorming techniques should be designed to yield ideational conflicts because creative ideas arise from the conflict and confusion. Victor A. Thompson complained about the conditions within a bureaucracy led by monocratic social structure. Driven by the purposes of productivity and control, those conditions do not contribute to creativity and should be changed. He suggested a looser, decentralized and evolving structure, which allows freer communications, rotation of assignments, modification of the incentive system, and changes in management practices. Empirical studies support the role of conflict in organizational creativity. Keith James and his colleagues found that conflict can enhance or hinder creativity depending on the situation and individual. Perceived conflict improved creativity on tasks that match an individual's orientation and reduced it for tasks outside of that orientation.

Objective Assessment of Asynchronicity

As Gardner and Wolf acknowledged, finding asynchronicities is not difficult. That can make the concept more elusive and subjective for scientific study. As a matter of fact, even with the benefits noted above, there is no objective way of assessing both asynchronicities and synchronicities. The lack of empirical research on asynchronicity is a corollary of the absence of objective criteria. However, some special methods of measuring creativity are based on ideas similar to asynchronicity. One such example is the Chiara S. Haller and Delphine S. Courvoisiers approach to personality tests as an indicator of asynchronicity given the premise that the response pattern of creative people is complex. Complexity of the responses stems from the presence of contradictory traits in their personalities. They hypothesized that creative individuals will be inconsistent in their responses to test items, choosing contradictory poles. Therefore, we would see more variability in the responses of creative people than in those of non-creative people. They tested this hypothesis by comparing students from art and psychology majors. They found that complexity in conscientiousness was greater among visual art students than music and psychology students, and visual art students show greater overall complexity than psychology students.

Preference for oscillating between contradictory poles was the basic principle of a new scoring method for divergent thinking tasks that Selcuk Acar and Mark A. Runco (2015) developed based on the theory of complex personality. They identified 11 dimensions that can be objectively identified in the responses to the divergent thinking tests. Another idea that is consistent with asynchronicity is to measure creativity based on the hypothesis that creative people prefer asymmetry over symmetry. The Barron Welsh Art Scale is an example of this kind. The scoring was based on whether participants like or dislike the stimuli, some which are either symmetric or asymmetric. The underlying idea is that creative artists prefer asymmetric, irregular, or even chaotic figures.

John C. Rosen found that this test discriminated artists from non-artists, while scores were not significantly different between art students and established artists. Further attempts to clarify the definitional scope and objective assessment of asynchronicities would stimulate studies of the role of asynchrony in creativity.

Conclusion

Asynchronicities are many in the lives of creative people and can be classified into three groups—personal, impersonal and multi-personal, or two groups—interpersonal and intrapersonal. The view of asynchronicity provides a unique perspective in understanding creativity, and the wide range of asynchronicities complies with the recent conceptualizations of creativity as “syndrome”. A certain level of asynchronicity seems to be helpful for creativity, but too much may be counterproductive. A critical issue regarding asynchronicity research is the difficulty in assessing it as we lack objective measures. Asynchronicity also challenges the view of person-environment fit, which asserts that a synchrony between the person and environment is favorable for creativity. Further studies are needed to resolve that controversy.

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Attention

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Introduction to Attention

Everyone knows what attention is. It is the taking possession by the mind...of one out of what seem several simultaneously possible objects or trains of thought.....it implies withdrawal from some things in order to deal effectively with others

This quote from the eminent American philosopher and psychologist William James (1842–1910) elegantly illustrates his view on attention. In his influential book “The Principles of Psychology”, he proposed that the mind is a continuous stream of thought and that attention helps us “pick” from this stream. One of the earliest formalized models of attention was proposed by Broadbent in 1958. This model offers a metaphor for attention as a filter, which selects certain stimuli for further processing while filtering out irrelevant information. This theory was later revised by Treisman, who addressed the short-comings of the original. Since then, other models of attention have been proposed, however the original frameworks still remain influential. Regardless of the theory, it is generally assumed that selection of key information at the exclusion of others (or selective attention) is necessary, since cognitive resources are limited in capacity. Shifts in attention can be driven by external events and also be under internal, voluntary control. Since creativity, like most other aspects of cognition, involves selection of some information at the exclusion of other information, it may be natural to question how creativity is associated with attention and indeed this is a topic that has been enthusiastically pursued in research.

Two of the most prominent theories linking attention and creativity include defocused attention and flexible attention—the ability to switch between the focused and defocused modes of attention. This chapter discusses each of these theoretical perspectives in detail, together with the associated evidence. It also reviews exciting research linking attention and creativity, including the effect of mindfulness on creativity and research in people with Attention Deficit Hyperactivity Disorder (ADHD). Following this, theoretical concepts aiming to bring these conflicting views together are discussed, as well as suggestions for future research.

Many studies discussed in this chapter used standardized measures of creativity, which can be classified under two broad categories: tests of divergent thinking and tests of convergent thinking. Divergent thinking generally involves providing solutions to an open-ended problem, to which multiple correct answers are possible (e.g. an alternative uses task asks to provide unusual uses for common objects). Convergent thinking, on the other hand, involves drawing on existing knowledge to arrive at a solution to a specific problem with constrained parameters where only one correct answer is possible (e.g. the Remote Associates Test asks to find a common associate linking three otherwise unrelated, words).

Defocused Attention

In the 1960s, Mednick proposed that creative people are able to connect distant ideas and concepts to arrive at creative ideas and solutions. It has also been suggested that a wider, or defocused, breadth of attention allows creative people to pay attention to information that others may find irrelevant. As a result, they are able to connect previously unrelated concepts to arrive at creative solutions, more so than people who have a focused breadth of attention and only pay attention to information that is relevant to the task at hand. Defocused attention has also been described as “over-inclusive thinking”, and “leaky”, or “diffuse” attention. The defocused attention view of creativity has been supported by findings indicating that people high in creativity are better able to utilize incidental or irrelevant information using experimental tasks. One of the earliest examples of such a task comes from the 1970s by Dykes and McGhie. In their study, participants listened to words played through headphones. Importantly, different words were presented to each ear and participants were asked to attend to the words played in one ear and ignore the information heard in the other. Participants who scored high on a creativity-related measure remembered more words from the irrelevant ear in

a subsequent recognition test than participants scoring low on the creativity-related measure. This link has also been demonstrated using self-report. For example, [Kasof \(1997\)](#) found that creativity was correlated with a self-report measure of breadth of attention. More recent findings also indicate that performance on creativity tasks such as the Remote Associates Test (RAT) is significantly related to participants' use of incidental information.

Another strand of evidence for the defocused attention view of creativity comes from studies on latent inhibition. A latent inhibition task involves presenting a stimulus (e.g. tone, light, or background color), which is later made to signal an event (e.g. onset of a picture on the screen). Generally, people learn to ignore the pre-exposed stimulus as it is considered irrelevant; there is a delay in learning this association compared to that involving a stimulus which was not pre-exposed. This is referred to as the latent inhibition effect. People who score high on creativity measures, however, tend to have a smaller latent inhibition effect—it takes them less time to learn the association involving the pre-exposed stimulus. Evidence from latent inhibition studies demonstrates that creative people are more likely to pay attention to previously irrelevant stimuli, although there is some evidence that this may depend on the exact types of tasks and measures used ([Zaksaitė et al., 2017](#)).

An interesting approach to studying the influence of defocused attention on creativity has been used by Jarosz and colleagues. They asked participants to solve RAT problems while under the influence of alcohol. They found that alcohol consumption increased the number of RAT problems which were solved; the time taken to solve these problems was also faster. They suggested that the reason for these findings is that alcohol results in decreased attentional control, providing further evidence for the role of defocused attention in creativity.

It has also been proposed that positive mood broadens attention. A study by Rowe and colleagues in 2007 found that people were more susceptible to distraction in an RAT task after a positive mood was induced. All these strands of evidence indicate support for the link between defocused attention and creativity. Next, we discuss two further contexts which are useful for demonstrating the link between creativity and defocused attention—mindfulness and ADHD.

Mindfulness

Mindfulness practices involve manipulation of attention in order to focus on the present moment making it a fascinating context to study the link between attention and creativity. It has received significant interest from the wider scientific community in the past decade. Although the concept of mindfulness and its practices are highly varied, it can be classified into two main types: Focused Attention (FA) and Open Monitoring (OM). The FA practice involves focusing on an “anchor”, usually natural breath, to bring attention to a particular point on the body. Other commonly used anchors are physical objects, thoughts, or sounds around the practitioners. In contrast, the OM practice encourages individuals to “set the mind free”, allowing any thought or emotion to arise without judgment. Because FA practice involves focusing attention, we may expect it to promote a focused attentional state, while the OM practice may be expected to promote a defocused attentional state.

Studies have successfully demonstrated that practicing mindfulness is linked with reduced stress, enhanced positive feelings, reduced anxiety, and increased pain tolerance. However, in recent years interest has moved beyond investigating mindfulness as a mere well-being tool. For example, studies have shown that mindfulness training enhances the ability to use attention efficiently. There are also numerous examples of artists who practice mindfulness to support their creative process. In their book “Wired to Create”, authors Kaufmann and Gregoire quote a number of creative people who acknowledged the importance of mindfulness in their creativity. For instance, Steve Jobs, the co-founder of Apple Inc. and the mind behind the highly successful iPhone, said that meditation was the main source of his creativity. Given this anecdotal and scientific evidence, it has been predicted that a link between mindfulness practice and creativity may also exist, with mindfulness exerting a positive effect on creativity.

In 2012, a group of scientists ([Colzato et al., 2012](#)) investigated the possible impact of mindfulness based on FA and OM on divergent and convergent thinking. They asked practitioners of both FA and OM techniques to take part in their study. After each mindfulness session practitioners also completed the alternative uses task and a short version of the RAT. This study showed that scores on the alternative uses task were higher for all participants after the OM sessions but not after the FA sessions. On the other hand, performance on the RAT was unaffected by either technique. The authors reasoned that the OM sessions, by encouraging participants to pay attention, and be open to any arising thought or emotion, induced a distributed attentional state. However, they also suggested a possible role of mood in explaining their findings and called for further investigation.

It is important to note that there have also been studies which did not demonstrate a link between mindfulness and creativity. These conflicting results were attributed to (i) a range of different creativity tests used, (ii) a range of mindfulness practices used and (iii) the multifaceted nature of both mindfulness and creativity. For instance, Domino published a study in 1977 with four groups of people. One group was enrolled in a meditation program, the second in a relaxation program, the third group was enrolled in a psychology course focused on enhancing creativity, and the fourth group underwent no special treatment. All four groups were given a battery of five creativity-related tests both pre and post treatment. Among these tests were the RAT and the adjective checklist. This study found that only the third group showed significant increase in creativity performance thus finding no enhancing effects of mindfulness on creativity. Importantly however, this study and others which failed to find the effects of mindfulness on creativity used a type of meditation that was similar to FA mindfulness practice, while Colzato et al.'s results suggest that it is the OM practices that are related to creativity. Based on Colzato et al.'s results, it may also be expected that mindfulness has stronger effects on divergent thinking, rather than convergent thinking performance.

More recently, [Baas et al. \(2014\)](#) conducted a series of studies to systematically disentangle the effects of FA and different facets of OM mindfulness practices on creative performance. In the first of these studies, they measured participants' ability to “act with full

awareness” with a measurement tool called Mindful attention awareness scale (MAAS). “Acting with full awareness” is similar to the FA practice; it is the ability to “fully engage in current activities with undivided attention, or focus on one thing at a time with full awareness”. People were encouraged to voluntarily direct and sustain their attention on a selected anchor (such as breath). Mind wandering, bodily sensations, and thoughts were closely monitored, and once people were aware of these, they were encouraged to disengage from these distractions and bring their attention back to the anchor (akin to focused attention). Participants also completed a divergent thinking task; they were asked to provide as many creative ways to use a brick as possible. Their study demonstrated that FA practice was linked with lower scores on this creativity-related task. Their second study looked at other components of meditation namely *observation*, *description*, and *acceptance without judgment*. *Observation* is similar to the open monitoring practice used by Colzato et al. (2012); it is the ability to attend to various stimuli and may be assumed to promote a defocused attentional state. *Description* is the ability of a person to verbally describe observed phenomenon without an evaluation. This entails actively labeling the thoughts and emotions as they arise. Finally, *acceptance without judgment* practice is the ability to be non-evaluative about the experience of the present moment. An example of this would be the ability to refrain from evaluative labels such as “good” or “bad”, as related to thoughts and emotions. In this study, creativity was assessed using a creative achievement questionnaire, a questionnaire asking about their ability to come-up with creative ideas, and through a divergent thinking task asking the participants to provide unusual uses for a rope and a tin can. This study showed that *observation* was associated with enhanced creativity: it led to significantly enhanced originality and flexibility in ideas, creative achievement, and self-reports of creativity. On the other hand, *description* and *acceptance without judgment* practices only predicted flexibility in ideas; they were not associated with any other creativity-related measure. A final longitudinal study was conducted to establish whether open monitoring mindfulness practice leads to enhanced creative behavior. Participants completed an 8-week mindfulness course with a focus on enhancing observation practice. They were instructed to undertake independent meditation sessions every day for a period of 20–30 min in the mornings and evenings. Creativity was measured before and after the 8-week course by a creative behavior questionnaire in which participants reported the frequency with which they engage in creativity-related behaviors such as “I often come up with original solutions for problems”. This study found that mindfulness training with an emphasis on observation led to enhanced creative behavior in a group of randomly selected volunteers, relative to the other forms of training. These robust findings offer more conclusive evidence that mindfulness practices lead to enhanced creativity. This is generally attributed to open monitoring mindfulness practices promoting a defocused attentional state, though this still remains to be demonstrated experimentally.

Attention Deficit Hyperactivity Disorder

Another way to explore the links between attention and creativity is by studying atypical populations in which attention may be implicated. For example, ADHD is characterized by symptoms of hyperactivity, impulsiveness and importantly, inattentiveness. ADHD is often diagnosed in childhood, but the symptoms can continue into adulthood, with an estimated prevalence of 2.5% (Simon et al., 2009). While the exact nature of attentional symptoms in ADHD is still being investigated, studies have found that ADHD can result in difficulties with attention and a greater susceptibility to distraction. This suggests that people with ADHD may exhibit greater defocused attention. Considering the defocused attention view of creativity, it might be expected that people with ADHD would have greater creativity. Some studies have indeed found that people with ADHD perform better on certain creativity tasks. For example, White and Shah (2006) found that adults with ADHD scored higher on a divergent thinking task than adults with no ADHD, while adults with no ADHD performed better on the RAT. These findings have also been partly replicated in a follow-up study in which the authors found that people with ADHD had higher originality scores on a verbal divergent thinking measure, while their performance did not differ on figural divergent thinking measures. They also found that people with ADHD scored higher on self-reports of creative achievement.

A study conducted by Zabelina et al. (2014) looked at subclinical symptoms of ADHD and creativity-related measures. They found no association between scores on a self-report ADHD symptom scale and divergent thinking performance, but a positive relationship between scores on the ADHD scale and creative achievement. However, they also found that this link was moderated by academic achievement—when academic achievement was considered, the link between ADHD scale and creative achievement became non-significant. Interestingly, other studies have also found that intelligence is implicated in the ADHD–creativity link. Carson et al. (2003) suggested that intelligence may act as a moderator of the relationship between a particular psychological phenomenon and creativity. Certain psychological phenomena may be sub-optimal in the presence of intelligence levels below a certain threshold but become advantageous in the presence of high intelligence as this may afford further resources to compensate for any associated difficulties; this is known as the threshold theory. In their study, they investigated latent inhibition (propensity to ignore previously irrelevant information discussed in the previous section) and found that while latent inhibition was negatively related to creative achievement, this effect was moderated by intelligence. Furthermore, studies which have found superior divergent thinking performance in participants with ADHD have often used college-student samples, which would likely selectively oversample people with average or above average intelligence relative to the general population. Therefore, this could be one reason for the contradictory results regarding ADHD and divergent thinking, although note that the relationship between creativity and intelligence may not be as straight-forward as outlined by the threshold theory (e.g. Kim, 2005).

However, recent findings by Boot et al. (2017) raise a question about whether the relationship between ADHD and creativity-related measures is due to difficulties with attention. They found that it was the hyperactive/impulsive symptoms that seemed to be responsible for the relationships between ADHD-symptoms and creativity, rather than in attentional symptoms. In particular, hyperactive-impulsive symptoms were positively associated with self-reported creative achievement and divergent thinking, but

negatively related to performance on the RAT. In attentional symptoms were not related to any creativity indices. While these results may appear surprising, there may be a relatively straight-forward explanation for them. Impulsivity is associated with risk-taking behavior and creativity has been found to be related to risk-taking, particularly social risk taking (Tyagi et al., 2017). Therefore, while the link between creativity and ADHD has been shown, whether this link is due to broader attentional scope is less clear, suggesting the need for further investigation.

Flexible Attention

As outlined in the previous sections, there is a substantial body of literature supporting that defocused attention is important for creativity. Note however, that the importance of focused attention has also been acknowledged. Martindale (1995) was one of the first to formalize a theory which considered that both defocused and focused attentional states are important for creativity and each serves its own function in the creative process. His view was that creative people are better able to alternate between the two different states of attention: a free associative state which corresponds to defocused attention and a logical, goal-orientated state which corresponds to focused attention. He suggested that the former, defocused attention state, is important for linking previously distant concepts in order to come-up with creative ideas. The latter, focused attentional state, becomes important when the creative ideas have to be selected, elaborated, and refined. In this way creative people might have the ability to switch between focused and defocused modes of attention based on the demands of the task or situation at hand. This ability to switch between the different modes of attention is also referred to as flexible attention, cognitive control, or cognitive flexibility.

Support for Martindale's view of creativity comes from tasks which involve either high or low ambiguity and interference from irrelevant or distracting information. An example task of low ambiguity and interference would be a simple reaction time task involving responding as fast as possible to the appearance of a target. An example of a task with high ambiguity or interference would be the Stroop task, which involves looking at words of colors (e.g. "Red", "Blue"), which are printed in differently colored ink, e.g. the word "Blue" printed in green ink. To perform correctly, participants have to name the color of the ink while ignoring the written word. Generally, people perform poorer when the color of the ink is different from the color of the word e.g. the word "red" printed in blue ink, than when the color of the ink matches the written word e.g. the word "red" printed in red ink, indicating interference from the written word. Martindale and colleagues hypothesized that on tasks which involve low ambiguity or interference, creative participants would benefit from focused attention and they would have superior performance. However, on tasks which involve high ambiguity or interference, a defocused mode of attention would be used and creative participants would have lower performance. In a paper published in 2007, they investigated these predictions. To indicate creative potential, they used a composite measure of scores from an RAT task, an Alternative Uses Task, and the Creative Personality Scale. They used four reaction time tasks which involved either high or low interference. The findings were consistent with their predictions—participants who scored high on creative potential measures were faster at responding on the tasks which involved minimal interference, but slower on tasks which involved high interference. These results have been partly replicated in a follow-up study.

One further strand of evidence for the flexible attention view of creativity comes from studies looking at people's ability to switch between different perspectives. One example of such is a Navon letter identification task, which measures the ability to switch between local and global levels of information. This task involves presenting letters which are made of smaller letters. The global letter can be either the same as, or different from, the smaller letters (e.g. an H can be made-up of Hs or Ns, see Fig. 1). Participants are asked to pay attention to the local level while ignoring the global letter, or pay attention to the global level while ignoring the local letters and this varies across different blocks. There is some evidence to suggest that performance on the Navon task is related to performance on divergent thinking tasks: participants scoring higher on divergent thinking have been found to be faster at reporting the letters at the correct level.

A recent study by Radel et al. (2015) used an interesting method to investigate the link between divergent thinking and flexible attention. Generally, tasks investigating underpinnings of creativity-related outcomes use correlational approaches, which at times can be problematic (e.g. they are dependent on sample size, variations in the sample, and it is difficult to infer the direction of causality). In their study however, they used an experimental approach. Participants performed a task which required either high

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Figure 1 An example figure used in the Navon task. (adapted from Navon, 1977).

or low levels of inhibition. The inhibition task was a visual-search task—participants had to respond to a target, while ignoring distractors. After performing this task, participants were asked to complete an alternative uses task. The authors reasoned that engaging in a task which requires sustained inhibition would deplete one's inhibitory resources and they would be less likely to engage in inhibition subsequently; this was also shown experimentally as participants' responses were worse on a task requiring inhibition after completing the demanding inhibition task. They found that after a demanding inhibitory task, originality and fluency scores on the alternative uses task were higher than after a less demanding inhibition task. These findings are consistent with the theory from Martindale and colleagues—they reasoned that higher creativity would result in poorer performance in tasks involving interference due to defocused attention. By definition, being more distracted by irrelevant information means that creative participants are worse at inhibiting or ignoring this information. Radel and colleagues' findings that lower inhibition (or greater depletion of inhibitory resources) resulted in better performance are consistent with this view, and may provide some evidence for the flexible attention view of creativity.

There have been several attempts to describe how the defocused, focused, and flexible attention views of creativity can be linked. For example, the dual pathway to creativity model proposes that creative ideas and products can be achieved through cognitive flexibility, cognitive persistence (which approximates focused attention), or a combination of both. The model assumes that different psychological phenomena which are associated with either cognitive flexibility or persistence would be positively associated with creativity and has received some support. Another example of bringing these perspectives together comes from Zabelina (2018) who proposed a "Model of Creativity and Attention". After reviewing the available behavioral and neurological evidence, she proposed that real-world creative achievement is associated with defocused attention, while flexible attentional control, or the ability to switch between the different modes of attention is important for performance on divergent thinking tasks, as it serves to inhibit the common, ordinary responses. Note that Zabelina's predictions seem somewhat contrary to Radel and colleagues' results—they found that lower inhibition was related to higher performance on a divergent thinking task, while Zabelina's model predicts that lower inhibition (of common responses) would be related to lower performance on a divergent thinking task. This suggests that further investigation may be needed to specify the mechanisms of how inhibition functions in creative participants and how this relates to flexible attention.

Overall, while there is evidence for the role of flexible attention in creativity, further work needs to be done to specify the mechanisms behind this link. Given the variety of measures used to indicate creative behavior, achievement, and potential, as well as numerous indices within a particular task (e.g. divergent thinking responses can be scored for originality, fluency, flexibility, and elaboration), it is possible that different types of attention may be related to different performance indices, as proposed by the promising, recent frameworks, though the exact nature of the mechanisms involved remains to be specified.

Conclusion

A rich array of research has linked creativity with defocused attention, including studies on latent inhibition, alcohol intoxication, mindfulness, Attention Deficit Hyperactivity Disorder, as well as studies on people's ability to use incidental information. These provide evidence that creativity involves the use of information that may be considered irrelevant. Creativity has also been linked with the ability to switch between the focused and defocused modes of attention, also referred to as flexible attention. Several theories and models have been proposed which attempt to unify these different strands of evidence. While they provide some elegant solutions, they may need further conceptualization to unify the existing results with theoretical predictions, and to qualify the seemingly complex relationship between creativity and inhibition. It is clear that while we know a lot more about the links between creativity and attention than we did a century ago, important questions still remain. In addition, further research is needed to clarify the link between different tasks and measurements related to creativity, perhaps using experimental methods.

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Attribution[☆]

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Introduction

Creativity is a complex process and cannot be understood from just one perspective. It has predominantly been studied in terms of cognitive and personality processes, but recently situational forces have intrigued researchers. Attribution theory is a social psychology view which aims to understand the way people give reasons for and draw meaning from the others' behaviors. Attribution theory deals with people's responses to questions beginning with "Why?—Why people do the things they do?" If there is not an obvious answer for a behavior, then people tend to create their own explanations for this behavior.

Attribution theory was originally developed by Fritz Heider (1958) who is one of the most important social scientists of the 20th century. According to Heider, there are basically two explanations for behaviors—external causes or internal causes. Approximately 10 years after Heider's discussion on attribution theory, Harold Kelley extended it. According to Kelley, attribution theory analyzes cause and effect relations. It can be related to every area of psychology that involves judgment, perception, and thinking. Given the importance of environment is clearly indicated in the seminal frameworks of creativity (i.e. role of four Ps—person, press, process, and product) application of attribution theory to creativity is not surprising. Attribution theory was first applied to creativity in a very detailed article by Joseph Kasof (1995) in a special issue of the *Creativity Research Journal*. That Featured article was followed by a series of Commentaries. In this chapter, I will discuss the attribution theory and the reactions of creativity researchers, including those of the CRJ Commentators.

Background and Basic Concepts

Creativity has both objective and subjective aspects. As often defined, creative products must be original, novel, and infrequent. This is the objective approach to creativity assessment and constitutes the main dimensions of many creativity tests. Objective assessments of creativity are based on normative criteria. One of the main advantages of objective creativity tests is the evaluation of creative products by blind judges. This yields high inter-rater reliability. However, from a subjective view, use of objective criteria seems to fall behind measuring creativity since creativity does not emerge in isolation. Creative products must also be approved or accepted by the "judges," and this is the subjective approach to creativity assessment because judges may vary in their perceptions and evaluations of a creative idea, solution or product. Kasof argued that objective tests ignore the subjective aspect of creativity by explaining all the variation in creative performance through individual differences. He claimed that objective tests tend to reduce ecological validity. Overreliance on objective tests discards the point that reception of original products is socially constructed.

When we consider the creativity as a "social construct," just as with evaluation of physical attractiveness, judgments of creativity also depend on social values. All judges have their own values, which influence their evaluations of the products. Judges—who may

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be scientists or experts but also laypeople—are the persons that decide whether a product should be approved, accepted, and valued. In “uncontrolled” real life settings, creativity is more about social judgment. In this view, even if the individual creativity is assessed, it cannot be thoroughly isolated from the social environment.

In a nutshell, attribution theory underlines *situational factors* and challenges the conventional theories of creativity which used to focus on *dispositional factors*.

Dispositional Versus Situational Factors

If the explanations of a behavior come from within the individual, this is called dispositional cause. Throughout the centuries, both researchers and laypeople have attributed creativity mostly to genes, brains, personal traits, and so on. For instance, Plato defined creativity as an inspiration, a kind of madness. According to Aristotle, the creative process is the product of natural laws; in other words, creativity comes from something that exists naturally. Kant also saw creativity as the kind of genius. He emphasized the unprecedented, spontaneous nature of the creative process. Galton, one of the most eminent scientists of the 19th century, extended Darwin’s theory to creativity and defined creativity as an inherited ability.

In academia, creativity has been the subject of cognitive and personality psychologists rather than sociologists or social psychologists. Creativity first appeared as a concept in psychology literature in Joy Paul Guilford’s Presidential Address, which focused on dispositional causes. This tradition has become the mainstream with the contributions of E. Paul Torrance, Frank Barron, Mark A. Runco and many others. This situation is not different for laypeople. According to most of the people, creativity is a quality of persons and a personality trait. Thus, people either have it or not, and most people do not have it. Laypeople mostly do not think that creativity can be a continuum and all people can have it to some amount. This dichotomizing view could be a result of the overall tendency of the field to examine the personal differences between creative and noncreative individuals.

During the past 20 years, in addition to Kasof, Teresa Amabile, Mihaly Csikszentmihalyi, Beth Hennessey, Keith Sawyer, Dean Keith Simonton, and other researchers have focused on situational factors as well as dispositional ones. According to those researchers, creativity is not only a product of an individual effort but also a product of complex social systems. Their research indicated the influence of rewards and external motives, field and domain, and political situations and zeitgeist on creativity. Kasof did not negate the relationship between dispositional characteristics and creativity. However, he doubted the direction of the relationship between dispositional characteristics. Contrary to the common assumption, such characteristics can be the results rather than the causes of creativity.

According to Amabile (1982), experimental studies on social and environmental factors of creativity is not very common because of the lack of clear operational definitions and reliable assessment methods that fits the social psychological views of creativity. She offered consensual assessment technique as a creativity assessment methodology from a social psychological perspective. According to this technique, judges—observers, raters—in a field can decide if a product is creative or not. Like as the judgment of physical attractiveness, judgment of creativity depends on the social context.

According to systems model of Csikszentmihalyi (1999), in order to understand creativity, we need to look at it from a broad perspective, as a social and cultural production. What is creative and what is not depends on the reasonable changes in the culture, so it is important integrate individual experiences with social perspectives of creativity. What makes a product creative is not only the individual quality of the product, but more importantly, if it recognizes as creative by others. Fields of creativity is one of the three key concepts of systems model and members of the field decide what is novel, or creative, in a domain. For instance, evaluation of the Van Gogh’s paintings changed later because the field change its criteria. If the members of this field did not change their criteria for creativity, those paintings would be never recognized as creative and, most probably, forgotten.

Factors Leading to Attributional Bias

When people try to explain other’s (or their own) behaviors, several factors cause attributional biases. The following sections will address these factors.

Covariation Principle

Covariation principle was introduced by Harold Kelley who defined it as attribution of an effect to one of its potential causes with which it covaries over a period time. Something might be the cause of an event, if it present when the event occurs and not present when the event does not. Covariation principle applies to the situations in which the attributors observed or noticed the effect two or more times. Accordingly, shifts from one kind of behavior to another yield different attributions for different reactions to this behavior. A famous example, known as the prisoner’s dilemma, indicated that people’s attributions regarding the same behavior pattern of a person can differ depending on the response of the reactant. In one case, a group of people observed two people, one of whom behaved cooperatively and the other also reacted cooperatively. When the first person, in turn, behaved competitively, most of the judges believed that first person was competitive. In the other case, the actions of the first person were the same (cooperative and competitive, respectively) while the reaction was competitive in the second case. A smaller size of the observers believed the first person was competitive. The attribution of being “competitive” about the first person is higher when the response of the second person is cooperative than when the response is competitive.

Three type of covariation information is useful to make attributions: consensus, distinctiveness, and consistency. *Consensus* refers to generalization across persons. When people make attributions, they tend to consider whether all individuals behave similarly in

a given situation. *Consistency* is generalization across time. People often consider if a person behaves similarly in other similar situations. *Distinctiveness* is generalization across situations. It explains if a person behaves similarly in different situations. People can know that their judgments are true if the judgment is associated distinctively with the stimulus (distinctiveness), if the judgment is similar to the judgments of other people (consensus) and if the judgment is consistent over time (consistency).

These three criteria are vital for attribution validity; however, according to Kasof (1995) they are not equally important. Consensus is more important for attributions of creative behavior than consistency and distinctiveness. The most important characteristic of creative behavior is originality and there is a negative correlation between originality and consensus. If the originality of a creative product increases, its consensus value decreases, and lower values for consensus cause higher internal attributions. Thus, highly creative behaviors are attributed to more internal causes than fewer creative behaviors. On the other hand, noncreative behaviors are attributed to dispositional factors only if the situation strongly supports the creativity.

Influence of number of creators on attributions may be a good example for the *covariation principle* in terms of *consensus*. The greater the number of creators, the higher the consensus and the more likely it is to be attributed to an external cause. Thus, when two or more scientists work on the same product independently, the consensus is higher than when it is made by only one scientist. Multiple creations are attributed less internally than single creations. In addition, if the multiple creators report the same creation at nearly the same time, the consensus will be higher, so the creation is attributed to more external causes. If two or more creators work on the same product at the same time, consensus is again higher than for single creations, so the creativity is attributed to external causes.

For consistency, if people behave creatively in a given situation over and over, their creativity is mostly attributed to dispositional causes. On the other hand, inconsistent creative products are attributed to situational factors, such as having a supportive boss for that time. If the creative product is not consistent, the creator has less of a chance to become well-known even if the product is really good and valuable. As a result, those with longer careers have more of a chance to become well-known because they have more opportunities to produce creative products than those with shorter careers.

Although distinctiveness is not as important as consensus, it still influences the attributions of creativity. If people are creative in all situations, distinctiveness is lower, so the behavior is attributed internally. But if the creative behavior is common in one situation and rare in other situations, the creativity is attributed to external causes. If a person is creative in different domains, distinctiveness is lower; therefore, creativity is mostly attributed to internal causes. Hence, if two creators create the same number of products, but one's products are in different domains, he or she is considered more creative than the other. Even within a domain, if people use different styles, materials, etc., they are considered more creative than others who use the same styles or same materials. Having information about consistency and distinctiveness affects people's explanations about creativity. Most of the time, however, attributions are made without information about consistency and distinctiveness.

The relationship between these three variables results in different kinds of attributions. Lower levels of consensus and distinctiveness yield internal attributions whereas higher levels for consensus and distinctiveness result in external attributions. Higher levels of consistency tend to lead to more stable attributions. More discrepant levels of consensus and distinctiveness (i.e., higher for one and lower one other) induce more complex attributions.

Salience

Salience plays an important role in the attributions of creativity. For example, think about the music group you like most. Who might be the most creative person in the group? Most people would answer, "The lead singer." Because singers are more salient than guitarists, bass players or drummers, people perceive them as more creative than the other members of the group. If a poet appears on a TV show, people think that he or she is more creative than other poets who rarely show up on TV.

Salience can operate in other ways, too. For instance, "wishing to be alone" is seen as a characteristic of creative persons. Creative persons are considered unsociable, alone and marginal ones, or unsociable, alone and marginal people are considered more creative than others. In a group, if a person has an unusual hair style or color, wears different from others and behave marginally, observers are more likely to believe that he or she is more creative than the other members of the group even if there is not any evidence to support this assumption.

Salience is also related to the number of creators especially in scientific creativity. Scientific work has become more collaborative; therefore, attribution of scientific creativity to internal causes has decreased. However, while experimental studies are often done by multiple creators, theorists usually work alone. Therefore, theoretical studies are still attributed mostly to internal causes. Similarly, collaborative studies are more common in science than in humanities, so creativity in humanities is mostly attributed to internal causes in contrast to creativity in science.

The relationship between creativity and salience is bidirectional. Creative products can also lead to salience because creative things are novel, and novel things are usually more salient. People tend to see salient products as a result of the personality of the creators and underestimate the impact of situations. However, there is an observer versus actor difference in salience. When an individual observes another individual in a situation, the observer perceives the actor as more salient than the situation, but the actor perceives the situation in which he or she is in as more salient than himself or herself. Thus, the observer attributes the behavior more to dispositions than the actor. Of course, this can be since creators experience the process, but observers can only see the product. This tendency of observers is known as *fundamental attribution error* which refers to the tendency of the observers to overestimate the dispositional factors and to underestimate the situational factors. It occurs more commonly for creative behaviors than any other behaviors because creative behaviors are more novel and original, so they are more salient than other behaviors.

The relationship between salience and creativity can also be seen in minority groups. Attributing creativity to people from minority groups is also common since they are highly salient. Therefore, creative people of minority groups are perceived as more talented than their actual performance, not just because of their creativity but also because of their rareness. According to Kelley, who introduced the *augmenting principle*, if both inhibitive and facilitative factors of a behavior are present together, the greater causal weight is given to the facilitative ones. For instance, psychopathologies or physical handicaps yield salience which might attract researchers' and lay people's attention more than others. There is a positive bias for schizophrenics in the creativity literature. However, a meta-analytic review with the analyses of 42 studies revealed that there is a negative correlation between chronic schizophrenia and creativity (Acar et al., 2018).

Stereotypic definitions of creative personalities can also be influenced by the salience effect. When we ask about the personality traits of creative individuals, lay people often describe them as nonconformists, independent, risk-takers, unsocial, and so on. On the other hand, it has been argued that creative people possess more complex personalities whereas people tend to notice the rarely observed and salient aspects. As a matter of fact, Mihaly Csikszentmihalyi, W. Ed McMullan, Frank Barron and others defined the most obvious characteristic of creative people as their complex personality. According to these researchers, creative people can bring together all the possible characteristics of humankind in themselves at the same time without any inner conflict. Nonconformity, independence and risk-taking are also characteristics of creative people, but they are exaggerated beyond reality.

Self-serving Bias

One of the main concerns of attribution theory is people's judgments about their own abilities, feelings, achievements etc. People usually attribute desirable outcomes to their personality traits and undesirable outcomes to environmental factors. For instance, reasons for acceptance, rejection or revision of the articles by journals were asked to 230 authors. They mostly attributed acceptance to internal causes but rejection and revision to external causes (Wiley et al., 1979).

Creativity, as a desirable characteristic, is also mostly attributed to internal causes. In a study, Brown and Rogers (1991) administered Remote Associates Test to a group of undergraduate students. However, half of the students received an easier version of the test than the other students. Of the students who received the easier version, and thus got higher scores than the other group, more believed that the test was fair and objective than did the students who received the harder version and got lower scores as a result. Studies showed that self-serving bias rules in brainstorming activities as well. People tend to attribute others' original ideas in the group to themselves (Stroebe, Diehl, and Abakoumkin, 1992).

Like self-serving bias at the individual level, groups can also take credit for their successes, and attribute failures to external causes. This is called "group-serving bias". Especially in the environments where team work is more important than individual effort, the locus of attribution shifts from individuals to groups. In other words, people try to explain success and failures of the group instead of their own success and failures. For instance, when a football team wins a game, they attribute success to their group cohesiveness, but if they lose, they attribute failure to external causes such as unfair referee.

Group-serving bias can influence judges' evaluation. Judges usually evaluate the products of members of their own group as more highly creative than the products of members of other groups. This bias occurs when the group members are in or out of their own environment during the evaluation period. For instance, products created by members of one's own sex are evaluated as more creative than those created by members of the other sex. People from the same nationality evaluate each others' products more highly than the products of others. Kasof exemplified Adolf Hitler who believed that all of the technological, artistic and scientific inventions in history were created by Aryan-Germanic people. Corollary to that, if people from other nationalities claimed that they created something, they just stole it from the Aryans, according to Hitler. Also, if a product says negative things about a group, the members of the criticized group evaluate the product as less creative even if it is evaluated as highly creative by experts.

Further Elaborations

There are other factors that can manipulate our attributions. They are general characteristics, status generalization, and social loafing.

General Characteristics

General status characteristics such as gender, race, age, physical attractiveness or socioeconomic status affect performance expectations for a group of people. A high level of competence is expected from people with certain characteristics even if there is no previous evidence for the relationship between the specific characteristics and task performance. According to Proudfoot et al. (2015) experiments, there is a gender bias in the attribution of creativity. Creativity is associated with mainly masculine characteristics (such as self-reliance) rather than feminine ones (such as supportiveness). Moreover, if they create identical products, men were attributed more creative than women and supervisors evaluated female executives less creative than males.

Although researchers, such as James Kaufman and Kyung Hee Kim, offered measurement of creativity as a solution for cultural bias in assessment, there is still some racial bias in attribution of creativity. Mark Paul Frederickson (1993) examined the racial bias in design school juries in architecture, interior design, and several studio arts across three US design schools. Among all 112 juries in those three schools, there is only one minority jury member, who is a male Hispanic American. In addition, Hispanic American students and African American students were also underrepresented in those design schools.

Another attributional bias in dying young. If a successful creator dies at an early age, he or she becomes more eminent in the future. This is mostly because people remember them at their most attractive ages. Eminent people, like all of us, lose their physical attractiveness and popularity as they become older. Thus, if they die before their success wanes, people remember them as more creative, not because they are really more creative but because people always remember them with their most attractive appearance and most popular products.

Status Generalization

When people come together to achieve a goal, their out-of-group status also affects their inner-group status. In other words, individuals with high social status have advantages in a wide range of areas, even if there is no evidence that such advantages are deserved. High social status is associated with general expectations of talent. Hence, usually the people who are famous out of the group are assumed to be more creative in the group as well. For instance, if a scientist in a group has won a Nobel Prize, it is assumed that this scientist contributed the most to the group, or in a multi-writer article the contribution of the famous scientist is assumed to be higher than that of a PhD student.

A status-based bias is known as the *third-party status effect*. If the judges know that other people evaluate a product as creative, their probability of evaluating the product as creative is high. How other judges approve of creations influences one's evaluation of the product. However, the third-party status effect has been demonstrated only with domain-specific status characteristics. High status judges are more effective than low-status judges.

Social Loafing

When people work in a group and the individual effort is not identified, people exert less effort than when individuals act alone. This is called *social loafing*, and it affects the attributions. Groups who attribute their creativity to the unique contributions of each individual create more divergent ideas than groups who attribute success to the group as a whole. Attributing creativity to the whole group rather than each individual sends a subtle message that each individual's contributions are not identifiable. When people think that their contributions are not identifiable, they exert less effort to create new things. If people think that they will be held individually accountable, they will be more willing to see the issues from different perspectives. Of course, if groups are not willing to search beyond the obvious ideas, they create less divergent ideas. Hence, it is a common finding that groups generate fewer creative ideas than individuals.

Groups' lowered performance in producing creative ideas can result from conformity pressure. Group focus attributions may increase conformity pressure. When people work in a group, they mostly ignore their own ideas and try to adopt the majority's opinion because groups have a tendency to reject members who do not fit. Thus, individuals can avoid from introducing their original ideas. Consequently, groups tend to see issues from only one or two perspectives and come up with less divergent ideas.

Like creators, judges are also influenced by the norms and values of their groups. Group norms have obvious influences on people's behaviors including how people recognize creativity. Csikszentmihalyi stated that creativity can only be understood in light of social norms and values. Although creative products should somewhat deviate from the norms, according to Mark A. Runco, if they are much ahead of their time, they might not be recognized as creative in their time. Some of the most famous writers or artists were not recognized during their lifetimes, but they became eminent posthumously. Due to the deviation of their products from their time, no attention was given to them. Hence, the norms and values of the era is one of the most important determinants of people's judgments about creative products.

But group norms and values do not influence everyone to the same extent. The level of being affected from the society is determined by individual's relationship with the group. As their personal identities, people also have social identities which internalize values and norms. If the group is important and meaningful for a group member and social identity is more salient than the individual identity, group norms and values become the primary source of the given member's judgments, and members confirm the judgments of the group. But if the judges' personal identities are more salient than their social identities, they can easily express their own judgments in the group.

The influence of social loafing is more visible when the creative products are judged by a group of judges. If judges know that they will be held individually responsible for their evaluations, their evaluations become more positive than when they know that the evaluations are pooled.

Criticism of the Attribution Theory

Creativity researchers have evaluated attribution theory in different ways. According to Teresa Amabile, attribution theory indicates some ways to develop more comprehensive work-related or school-related creativity enhancement programs. Most creative training programs aim to improve personal traits (such as creative thinking strategies), but with the help of an attribution theory perspective, creativity enhancement programs can also focus on the facilitative and detrimental effects of environments on creativity and can aim to improve environments to help creativity. On the other hand, Amabile criticized attribution theory for its claim that creators notice the environment when the environment prevents their creativity but attribute all success to their personality when the

environment assists their creativity. Amabile's and her other colleagues' findings, however, indicated that people mention environmental factors as much as personal factors, a fact which attribution theory overlooks.

Mark A. Runco was the most critical of attribution theory. He objected to attribution theory for several reasons. First, it does not explain what creativity is; instead, it explains individuals' reactions to the creative products. Judgments can be biased. If they are not true, this does not mean that the product is not creative; instead it can be creative but not recognized. Second, having a creative idea, sharing it with others and convincing others are all different things. Thus, there must be a distinction between inherent creativity and attributed creativity. Attributed creativity is important for reputation because reputations are estimated by others' judgments. But reputation is not creativity, and people's judgments cannot explain inherent creativity alone. Third, attribution theory can explain the creativity of eminent people, but it ignores the daily creativity, known as *little c*. People who are creative in their daily lives but not eminent can sometimes remain unrecognized. Of course, this does not mean that these people are not creative just because they are not reputable. Furthermore, reputations can also be biased. For instance, some highly reputable people may gain people's attention, not because of the creative value of their current work, but because of the influence of their previous work. The ability to communicate and convince others is not a good predictor of the ability to generate creative ideas. Fourth, attribution theory can be applied to creative products and performance, but not to creative processes and potentials. Therefore, according to Runco, attribution theory does not seem to be a resourceful perspective for creativity.

Another criticism for attribution theory is related to cultural differences. Several studies discussed that fundamental attribution error is a "Western Bias" and there are differences between the Western and Eastern attributions. Culture can influence the way people think, behave and interpret the world around them. Thus, people all around the world do not interpret the human behaviors, including creativity, in the same way. According to Miller (1984), people from individualistic societies make more personal attributions, however people from collectivist societies make more situational attributions. Takahiko Masuda et al. (2008) examined the arts that created in different cultures. Western artists highlight mostly individual people and objects in their works. However, Eastern artists draw more space to background and scenery. These cultural differences in art works were seen in both professional artists' and schoolchildren's works. In another study, Paletz et al. (2011) compared the attributions of different cultures in implicit theories of creativity. They asked the Japanese and American (Asian Americans and Caucasians) participants to list as many words for creative behaviors and traits associated with creative people. Results showed that Japanese listed more external and fewer internal creative activities and personal traits.

According to Robert J. Sternberg, dispositional versus situational views of attribution theory cannot be adaptable for creativity studies. He claims that creativity and the attributions of creativity are two different concepts and perspectives on attribution of creativity cannot be used to understand the theory of creativity. If we want to understand creativity, we need to look at both internal factors that lead to creativity and external factors that lead to attributions of creativity.

Michael M. Mumford criticized the attribution of creativity from a different perspective. He does not reject the importance of nonverbal cues, such as dress and gestures, on attributions. However, these cues cause attributions only if there is no evidence of performance or the judges lack expertise in the field. If there is enough information for the performance, judges focus on the objective outcomes rather than the subjective attributions and make evaluations accordingly. Thus, according to Mumford, people's evaluations of creative products or individuals are not as subjective as the attribution theory explained.

Conclusion

Creativity has often been studied in terms of dispositions. Attribution theory attempts to disclose the other aspect of creativity, which is basically about social reception of original ideas. It proposes that social and situational processes can determine the creativity of the ideas because creativity is not independent of the context in which it emerged. Attribution theory deals mostly (even only) with the subjective interpretations as the causes of people's judgments about creativity. However, subjective interpretations are commonly utilized in the evaluation of creative products. Yet, this does not mean that creativity can only be explained by situational factors; or that dispositional factors do not influence creativity. Creativity is a complex process and it cannot be well understood by just one explanation. Attribution theory simply highlights another aspect of creativity's complexity.

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Avocations

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Introduction

This essay explores the intersection of avocational pursuit with creative activity. At issue are those free-choice, non-remunerative pastimes that, as the Latin etymology of the word avocation would have it, call people away from proper work. These may range from the casual engagement of hobbies to the more extended commitments referred to as “serious leisure.” Also at issue are the skills and behaviors, purposes and outcomes that characterize human creativity. Creative activity is not to be confounded with artistic endeavor, *per se*. Rather it speaks to the combinatory processes that produce new and effective responses to cultural challenge of all kinds. How might avocational engagement inform creative contribution? If so, which avocations? By what means and to what effect? These and related questions guide modern understanding of leisure, interest and identity development, and avocational creativity.

The Leisure Question and Leisure Guidance

Modern interest in avocation and its influence on thought and behavior has historical roots in perennial conflict between work and play. Consider that the commercialization of leisure in eighteenth-century Europe raised concerns as to how different social groups chose to fill their free time. Whether the lower class worker brawled on a Sunday or attended an improving course of lectures was thought to have ramifications for Monday morning work. With hindsight, the issues of social and psychological control that ran through this and other debates may be appreciated. So, too, it is possible to recognize similar concerns at work in contemporary disputes about the amount of time adolescents or young adults spend on computer gaming, social media, or other “virtual worlds”—even as knowledge accumulates about avocations and their implications for creativity.

Avocations began to draw modern social and scholarly interest in the late 1920s, just as the stock market crash and ensuing economic depression cost enormous numbers of people their jobs. As Gelber (1991) pointed out, advances in technology had already affected the quality and quantity of work. Changes in social welfare had also made retirement possible for more people and at earlier ages. The combined result was a noticeable uptick in leisure time, both for the able-bodied and the elderly. Didactic advice for the unemployed stressed hobbies as a means of not “merely making a living, [but] actually making a life worth living” (Proctor, 1929, 356–357). Indeed, the hobby literature of the 1920s and 30s distinguished between productive and unproductive leisure, primarily, Gelber noted, “to expand the work ethic in a period when work itself was at risk” (1991, 741–742). So, too, the academic literature. How were the unemployed to acquire or demonstrate work skills and interests if no work was available? Posing that question and more, Super (1940) envisioned a reliable “guidance for leisure,” one based in the scientific study of avocation and its relationship to vocation.

Super proposed that avocations might demonstrate workforce aptitude. The question was, how might that be determined and how measured? Adapting to his purposes the Strong Vocational Interest Blank, a questionnaire that inventoried the individual’s preferences for work, amusements, and daily activities, Super compared avocational with vocational patterns among four groups of hobbyists: stamp collectors, model train/boat/airplane enthusiasts or engineers, amateur musicians, and amateur photographers. Individuals for study were solicited from hobby societies and clubs and only included teenage boys and men.

By and large, Super found that three of these groups—modelers, musicians, photographers—engaged in “vocational avocations,” that is, patterns of interests among hobbyists and professionals were similar. Model enthusiasts shared interest patterns with professional engineers. Additionally, they also shared interests with other technically oriented professionals such as chemists.

Amateur musicians were like professional musicians as well as journalists, chemists, and artists. Amateur photographers resembled commercial photographers, but also those at work in artistic, literary, and even scientific occupations. Stamp collecting alone seemed less predictive of any particular set of vocations, in part because it was unlike any one profession *per se*. It alone of the four was what Super called a “non-vocational avocation,” or true hobby. As such, it was deemed non-predictive for career guidance purposes.

Super observed an additional pattern among the hobbyists he studied. Stated as a principle, a person’s major avocation will resemble his occupation if the occupation suits his interests and abilities—in other words, the avocation “supplements” the vocation. The avocation will be different than vocation, however, if the work limits the individual’s desire to use certain of his skills or his urge to express himself in certain ways—in which case, the avocation “compensates” for the vocation. There were certain corollaries that followed: Men whose major avocations resemble their vocations will tend to be satisfied with their jobs and “better adjusted.” Those whose major avocations do not resemble their vocations and/or have a greater variety of major avocations, will tend to be dissatisfied with work and less well adjusted. Avocations, especially major avocations, were key to an individual’s “dominant interests” and the closer one could match avocation to eventual vocation the better, [Super \(1941\)](#) advised. Theoretically, he placed the individual’s psychology at the center of avocational and thus vocational choice—and allowed, too, for variation in their supplementary and compensatory relationship over time.

Serious Leisure and Avocation

Much subsequent work in leisure studies retained Super’s basic analysis of avocation and vocation: a typology of the “congruent,” the “compensatory,” and the “compartmented” or neutral relationship between work and leisure remains current today. Little effort was made, however, to explain why “particular work/leisure relationships arise – they just *are*” ([Veal, 2004](#), 110–111). Enter [Stebbins \(1979\)](#) and his lifelong study of this and other gray areas in the work-leisure relationship. From personal experience as a musician, he realized that in certain circumstances the professional and the amateur shared many qualities—especially with regard to the devotion both brought to their activities. In congruent situations, work shared some of the self-chosen enjoyments of leisure and leisure some of the serious commitments of work. Although the accepted dichotomy of work and leisure characterized the two as necessarily distinct and separate, [Stebbins \(1979, 1992, 2001, 2004\)](#) pioneered the investigation of avocation as if a vocation—i.e. as serious leisure.

Leisure is a concept that covers a wide range of activities, ranging from casual pastimes to dedicated hobbies. What Stebbins proposed to study as serious leisure was “the systematic pursuit of an amateur, hobbyist or volunteer activity that participants find so substantial and interesting that, in the typical case, they launch themselves on a career centered on acquiring and expressing its special skills, knowledge and experience” (2004, 49). Of the three types he investigated, the most relevant for understanding avocation is amateur activity. For Stebbins, the amateur was a part-time participant impelled by “necessity, obligation, seriousness, and commitment” (1979, 46). The hobbyist was someone somewhat different. Both amateur and hobbyist were practitioners with an enduring purpose, and yet their relationship to work was far different. The hobbyist, even if serious, engages in activity for which there is no known professional sphere—stamp collecting being a prime example. The amateur engages in activity for which there is a professional sphere—that of musician, for example—and yet, does so on the margins of the professional world.

Stebbins focused his research on associations of amateur actors, musicians, singers, archaeologists, astronomers, baseball players, football players, and magicians. Following his lead, other scholars widened the scope of amateur groups, particularly in art and sport. The solitary amateur proved of less concern, though Stebbins recognized the “systematic and fervent pursuit during free time of knowledge for its own sake” as serious leisure, very much like any other occupation subordinate to work (2001, 29). Possibly because these “liberal arts” pastimes do not create their own social worlds, he categorized them as hobbies. Because they do take place on the outskirts of thriving, academic professions, however, it would seem they more nearly fit the definition of avocation. No doubt in response to this and other ambiguities, Stebbins warned against drawing false distinctions among hobbyist, amateur, and professional:

...we must avoid the unidimensional thinking that pits the amateur against the professional in terms of, for example, little versus great skill, intrinsic versus extrinsic reward, avocational versus vocational orientation, or leisure versus work. While under certain conditions such dichotomies accurately describe their relationship, under many other conditions ... they badly distort that relationship. (1979, 44)

Indeed, Stebbins argued, amateurs make positive contributions to their associated professions and to society at large. Serious hobbyists and amateurs provide an educated audience for the professionals; they benefit their community by raising the level of participatory culture. The only consistent difference between amateur and professional, [Stebbins \(1979\)](#) and [Super \(1940\)](#) before him found, is one of remuneration: professionals commonly gain at least 50% of their livelihood from vocation, while amateurs typically make little or no money from their avocation. In many other ways, the two were nearly indistinguishable, particularly when engaged in “devotee occupations.” Usually found in the liberal professions and certain artisanal trades, such occupations allow the individual critical control over time and effort; they depend upon the individual’s substantial skill, knowledge, and/or experience; and they offer “significant opportunity for creative or innovative work, as a valued expression of individual personality”

(Stebbins, 2004, 9). Serious hobbies and avocations offer similar opportunity to develop creative behaviors, nurture motivation, and engage in productive creative endeavor.

Avocation and Creative Trait

Leisure in general promotes subjective well-being and life satisfaction. Serious leisure does as much and often something more. As Stebbins (1992) argued, serious leisure, like devotee work, may promote attitudes or traits that enhance creative readiness, including confidence, preparedness, perseverance, commitment, and strong identification as poet, musician, astronomer, and so forth. Psychologists point to many of the same traits and behaviors as characteristic of creative personalities. Confidence or self-efficacy, the ability to succeed in a set situation or accomplish a set task, is one. So is perseverance, the willingness to face and surmount obstacles in the way of skill acquisition, learning, and expressing. Runco suggested that persistence might actually be “a prerequisite for creative accomplishment” (2007, 295), if for no other reason than the sheer amount of time it takes to master necessary skills—at least ten years by some reckonings—or to usher an insight to fruition. Self-identification as a creative actor has also been strongly tied to actual creative outcome. Confidence in a skill set, willingness to commit for the long haul, self-identification as an artist, a scientist, a creator—these then appear to be core dispositions that shape and are shaped by avocational activity particularly and by creative activity generally.

Whether any individual, any amateur engaged in serious hobby or avocation, comes by these traits innately or nurtures them through practice is, of course, debatable. Psychologists have sketched out additional characteristics of creative personality, including openness, flexibility, tolerance of ambiguity, playfulness, imaginativeness, wide interests, and curiosity, all of which may depend on an eliciting environment as much as genetic endowment. In any event, Feist (1998) and others have observed that these traits, as well as confidence, perseverance, or practitioner identity, may make creative behavior more likely—they do not guarantee it or creative contribution. More is required, including motivation. Runco (2007) presented the case that the primary incentive for creativity is the individual’s need to actualize, to fulfill his or her potentialities. With regard to the motivations of serious hobby and avocation, scholars from Super to Stebbins would agree. Characterizing the development of new skills, abilities, and knowledge and the projection of a serious leisure identity as rewards, Stebbins put his finger on the positive emotional valence of serious avocational commitment.

Avocational Interest, Experience, and Creative Identity

Of the many personal rewards to be had from serious hobby or avocation, perhaps the most important when it comes to creative capacity is, in fact, the “durable benefit” of self-actualization (Stebbins, 1992, 126). First developed as a concept by Maslow in the 1950s, psychologists have since studied how interest, experience, and identity may contribute to the nurture of individual accomplishment. Needless to say, such study has its bearing on avocations, as well as the opportunities they provide for creative behavior and, in some cases, creative contribution.

Recall that serious hobby and avocation reflect the individual’s dominant interests. Silvia (2001) argued that these interests depend on the triggering of emotional interest. Emotional interest in this case is defined as the feeling of being engaged, caught up, fascinated, in a word, curious about some situational novelty, complexity, uncertainty, and/or conflict. Silvia’s model of interest development assumes that curiosity alone is not enough to create enduring interests, however. Magnification of some kind is required, for example, repeated encounters with activities that sustain the curiosity. Play and its persistent scenarios provide magnifying encounters for children; the play of hobby or avocation does much the same for more mature individuals. Hamilton-Smith observed that the optimal arousal of interest will tend to have a hedonic effect, “thus ensuring the continuity” of the rewarding behavior, whether knowledge-seeking or play-enhancing (1992, 249). Without repeated, enjoyable immersion in physical and mental activities, neither interests nor avocation would persist.

In fact, interests and avocations may be termed autotelic activities, intrinsically rewarding in and of themselves. Phenomenological study of autotelic activity locates the reward in a state of consciousness that Csikszentmihalyi (1975) has called the flow experience. The flow concept has been especially welcomed by scholars of leisure; Stebbins (2004) observed it may be the most studied reward in that discipline. Among other things, flow—and its outcomes—appear to be especially relevant to explaining the extraordinary commitment of the serious amateur. What does make an activity enjoyable, pursued for its own sake, in the absence of economic or other forms of support? The answer lies in a number of psychological effects that result under certain bounded conditions.

Consider those activities, whether physical (running) or symbolic (reading) or both (painting), characterized by a variety of challenges that require or call upon responsive skills (moving the body, recognizing letters and words, training the hand that holds the brush to execute the mental vision) in order to achieve some clear goal (a race run, a story read, etc.). When a more or less constant feedback lets the individual know that skill level is more or less in balance with challenge, the stage is set for psychological flow. During execution of the activity, the individual’s sense of time drops away and there is a loss of self-consciousness as attention concentrates and he or she becomes deeply involved in the action. To the extent that flow encourages repetition of behavior and activity, Csikszentmihalyi and Kleiber (1991) have argued, the immersive experience stimulates the acquisition of new physical and mental skills, which in turn contribute to an expanding sense of the self.

Sociologists have long been concerned with the formation of identity, particularly with regard to social role. In general, it is argued, individuals strive to affirm their inner nature through choice of outer activity. This is perhaps more the case for free choice,

intrinsically motivated leisure pursuits than for occupational undertakings constrained by extrinsic motivations and economic considerations. Serious and committed avocations are particularly symbolic of persona. The skills and practices of an amateur pianist or mycologist serve to represent the true self—not just to others, but to the self itself. In addition to a creative role identity, the amateur may also develop a creative personal identity, signifying “the overall importance a person places on creativity in general as part of his or her self-definition” (Jaussi et al., 2007, 248).

Along these lines, Stalp (2006) investigated amateur investment in what has been called a “subjective career.” The quilters she studied often defined success, not in terms of monetary recompense or even public artistic recognition, but in terms of values and goals independent of mainstream measures of professional achievement. What mattered was the acquisition of skill, self-expression, the gifting of quilts, and the consequent reinforcement of family ties and community traditions. Absent a recognized hobby community, solitary amateurs might also develop a sense of subjective career. M. Root-Bernstein (2014) observed that J.R.R. Tolkien nurtured interest in invented language, painting, and storytelling for many years before publication of his breakout fantasies of Middle-earth. His identity as creator was private before it was public. This expedient allowed him to reduce conflict with his role as professor of philology, and avoid condemnation from academic peers for wasting his time. Committed on his own terms to avocational world-building, he painstakingly acquired the skills, experience, and confidence that eventually led, in his case, to socially recognized creative outcome.

Avocational Marginality and the Transfer of Creative Effect

So far, this discussion of overlapping avocational and creative traits, experiences, and identities has focused on what Feist (1998) and others call motivational or affective factors. Put another way, up to now it has considered the potential for personal creativity to flourish in avocational activity. Most amateurs practice their crafts and callings in what Kuhn called a “normal” manner, i.e. in conventional terms. Normal avocational pursuit enables the individual to fulfill private aspirations for making, doing, and expressing *without* engaging in the kind of creative work liable to affect public or professional circles of understanding and endeavor. Nevertheless, some amateurs do aspire to socially-recognized achievement and some do make original contributions to knowledge and practice—Tolkien being one case in point. Most psychologists agree, however, that personal creativity alone is insufficient to explain this. Other factors affecting individual thought and activity appear to be necessary.

Feist (1998) and others have argued that norm-doubting, unconventionality, and/or asocial orientation play a critical role in publicly recognized creativity, especially that of major impact. So compelling is the case for the contrarian nature of eminent creators that marginality has often been considered a marker for extra-normal creative practice. Along these lines, Runco noted that both Skinner and Piaget explicitly recommended “intentional marginality” (2007, 285), such as reading outside one’s area of expertise or working at the far edges of one’s discipline. Sternberg (2003) argued that the individual may choose to be creative by purposefully adopting these or other likely intellectual strategies. As Stebbins (1979; 2001) pointed out, a limited marginality is also consequent to choosing avocational activity. Without violating the norms of society as a whole, amateurs find themselves on the periphery with respect, first, to their ambiguous posture between dabbler and professional; second, to their ambivalent position between casual leisure and work; third, to their “outsider position” in professional worlds, even as their skill and activity is judged by the standards of vocational practice. That said, Stebbins did not directly equate the social marginality of serious hobby and avocation with actual creative practice:

It would be inaccurate to assert that amateurs, because they occupy a marginal role, are therefore creative. But turned around, it is possible that some creative people, including amateurs (most likely those in art and science) are also marginal. (1979, 217)

In other words, for some individuals the limited marginality of a serious hobby may be turned to creative advantage, if only because the avocation provides a safe space for exploring interest absent professional risk. The question remains how. Feist (1998) suggested the necessity of additional cognitive traits or behaviors—openness (to fantasy, feelings, aesthetics and related values), flexibility (in the combination of ideas and practices), and imaginativeness (in the use of sensory based cognition) among them. Yet how any one of these dispositions may operate in the avocational setting to effect vocational outcome needs clarification. This is particularly so, when considering that the transfer of creative effect from one “social world” to another, from avocation to vocation, may actually be twofold. One might reasonably expect a dedicated amateur engaged in what Super called the vocational avocation to make creative contribution to the associated profession. It is less obvious how the amateur engaged in a non-vocational avocation might make creative contribution to an unassociated, apparently dissimilar profession. But that is exactly what occurs as cognitive strategies bridge the avocation-vocation divide.

Avocations, Tools for Thinking, and Creative Outcomes

Arts, Crafts, and Scientific Success

When and how do avocations set the stage for creative vocational contribution? First steps toward some answers emerged from the history of science and its long-standing fascination with how scientists discover and invent. By the mid-nineteenth century,

anecdotal observation had determined that eminent scientists not only had broad interests, but that these were more likely than not to manifest in arts and crafts avocations. Galton (1874) reported that unusual numbers of British Royal Society members were visually, artistically, musically, and mechanically skilled. A few years later, Van't Hoff (1878) disclosed the results of his study of several hundred biographies of famous scientists. Twenty-five percent of his sample, he found, engaged in some form of art, music, poetry, or literary composition. By the turn of the century, Claparède and Flournoy (1902/1904) announced that 52% of the professional mathematicians they studied pursued a musical avocation. In the first modern psychological study of scientific imagination, Roe (1953) found that members of the US National Academy of Sciences displayed extraordinary visualization skills. Subsequently, both C.W. Taylor (1963) and D.W. Taylor (1963) differentiated the most successful scientists from more average peers on the basis of extra-vocational literary ability and craft experience with hand tools.

Digesting this literature and more in his investigation of how scientists think and invent, R. Root-Bernstein (1989) listed over 400 scientists, inventors, and engineers known to have engaged in visual, plastic, musical, dramatic, and literary arts. Based on the evidence of memoir and self-report, he hypothesized that scientific creativity required mastery of certain “tools of thought” readily exercised in the arts, among them analogizing, pattern forming, pattern recognition, visual thinking, modeling, empathizing, and kinesthetic thinking. He further hypothesized that these mental tools helped integrate a scientist’s avocation and vocation as “correlative talents” into what Gruber (1989) called viable “networks of enterprise.” For Gruber, a network comprises work-related interests, projects, and activities that support one another, primarily by mediating intellectual frustration and distributing emotional and professional risk. Root-Bernstein was suggesting that amateur interests expressed in avocational activity—and non-vocational avocational activity at that—might also support vocational creativity, and primarily by exercising or enhancing imaginative cognition.

Subsequent statistical study offered support for Root-Bernstein’s conjectures. In a longitudinal study spanning over three decades, Eiduson (1962) had been tracking thirty-eight male scientists whose careers ranged from the mediocre to the heights of excellence, including receipt of the Nobel Prize. She noted that the highest achievers differed from the rest of the group, extending “themselves emotionally, not to mention physically, into the larger intellectual sphere of humanities without actually withdrawing time, energies and efforts from their work” (Eiduson, 1962, 258). Mining her data after Eiduson’s death, R. Root-Bernstein et al. (1995) found that the most successful scientists were all avocational artists, musicians, sculptors, and poets, whereas the least successful scientists were rarely so.

More to the point, avocations and vocational success both correlated independently with each other and with reported use of imaginative “tools for thinking” such as observing, abstracting, body thinking, modeling, or playing. The more artistic hobbies a scientist engaged in, the greater his probability of achieving eminence (as measured by paper citations). Visual arts and music were particularly predictive. In turn, arts avocations were significantly associated with thinking tools. Those who engaged in visual arts or music, for instance, tended to be highly visual thinkers, using 2- or 3- dimensional forms of imaging. Imaginative skills also directly correlated with success as a scientist. Those who were strong at visual imaging or employed kinesthetic feelings proved particularly creative in their work. In short, the more deeply engaged in arts hobbies, and the wider the range of thinking tools, the more likely the scientists were to be among the highest achievers in the Eiduson group.

Larger scale statistical study yielded similar results—and validated the arts avocation as a measure capable of discriminating between varying levels of achievement. R. Root-Bernstein et al. (2008) compared the avocational interests of all Nobel laureates in the sciences (1901 to 2000) with other elite groups of scientists, with average scientists (as represented by Sigma Xi, a scientific research organization open to all), and with the general US public. Among their findings, the avocational interests of average scientists did not significantly differ from those of the larger population. Things were significantly otherwise for elite scientists. Members of the US National Academy of Sciences and the UK Royal Society were almost twice as likely to have crafts avocations as the typical Sigma Xi member. Nobel laureates were almost three times as likely to have arts and crafts avocations as Sigma Xi members, and about 50% more likely to have such avocations than Royal Society or National Academy of Sciences members. Arts avocations effectively tracked the hierarchy of scientific contribution and success.

In subsequent study of science, technology, engineering, mathematics, and medicine (STEMM) professionals, R. Root-Bernstein et al. (2013) produced similar results: arts and crafts avocations correlated significantly with measures of scientific success and entrepreneurial innovation, as measured by patent output and the founding of high-tech companies. The effect was enhanced when the avocation was sustained, i.e. introduced in childhood or youth and maintained in adulthood. In further study of this same group of STEMM professionals, R. Root-Bernstein et al. (2019) found positive correlations also exist between particular arts and crafts avocations and particular thinking tools: modeling and playing, for instance, are correlated with persistent adult crafts avocations such as metal- and wood-working and mechanics, which are, in turn significantly correlated with patent production. R. Root-Bernstein et al. (2017/2019) observed that self-report confirms the statistics: by consciously drawing disparate disciplines such as arts and sciences into proximity, imaginative thinking tools form an important “bridge” between avocational and vocational activities. Other bridges, not yet assessed statistically, include the transfer of methods and materials, aesthetic principles, and facility with creative process itself.

Beyond the Science-Art (A)Vocation Network

To date, current evidence demonstrates strong correlation between scientific creativity and persistent avocation in arts and crafts. The question remains, is there an association between avocation, tools for thinking, and creative activity in general? R. Root-Bernstein and Root-Bernstein (1999) pored through hundreds of biographical and autobiographical records to determine whether the thinking tools germane to scientific work were also at play for creators in other fields. They were. No matter the discipline or its expressive products, creative individuals tap into sensory-based cognition before translating imagistic thoughts into words,

numbers, or other symbols. Keenly observing with all the senses, readily manipulating resultant mental imagery, focusing on essential aspects of a thing or process, patterning, empathizing, keying into bodily sensations, playing, modelling, and more all formed a core set of creative skills of universal value. Beyond the science-art nexus, thinking tools did indeed provide cognitive connections bridging different professions and pursuits.

Further investigations, both qualitative and quantitative, found that networks of vocational and avocational interest also cross disciplinary silos. In a study of imaginary world invention, M. Root-Bernstein (2014) found individuals combining apparently unlike avocations and vocations on the basis of complex play—Tolkien among them. Multi-disciplinary networks linking disparate arts, sciences, social sciences, and humanities were similarly found among Nobel Prize winners in literature. R. Root-Bernstein and Root-Bernstein (2004) reported that nearly a third of literature laureates (1901 through 2002) had adult avocations in some art other than creative writing, most often a visual art. In further ongoing study of Nobel laureates through 2008, Root-Bernstein and Root-Bernstein revised this figure to 44%. About one-fifth (since revised to 24%) of literature laureates also displayed avocational interests in science. Indeed, literature laureates were just a bit more likely to have serious interest in the sciences as Nobel chemists were to have serious interest in non-fiction prose and creative writing (19%).

Ongoing research on interest patterns among all Nobel laureates by Root-Bernstein and Root-Bernstein has further confirmed robust cross-disciplinary networks of vocation and avocation among Peace Prize winners and laureates in the economic sciences—though these patterns look quite different from those of science or literature laureates. Eighty-seven percent of economics laureates showed interest in the sciences (particularly math and physics, and to a lesser extent, psychology), yet they were far less engaged in arts, crafts, and literary writing than Nobel scientists. Peace Prize winners distributed their avocational interests rather evenly within the arts (22%) and sciences (19%), but at lower rates than science or literature laureates respectively. These distinct patterns of interest aside, the average Nobel laureate (those in science and literature as well as economics and peace) demonstrated interest and/or avocation in 2.3 out of seven activity areas or fields of knowledge and practice: arts, crafts, writing, humanities and social sciences, sciences, nature immersion, and sports. Sizeable proportions of Nobels engaged in three or more of these activity areas; very few, though there were some, engaged in six or seven. Networks of interest among Nobels run broad as well as deep (see Polymathy).

(A)Vocations and Creative Impact

Evidence suggesting that avocations do indeed have creative impact on vocations must now be considered. In studies of thousands of Israeli youth, Milgram and Hong (1993) and Milgram et al. (1997) found only one reliable predictor of career success—participation by the individual in an intellectually demanding avocation over a long period of time. Indeed, Milgram (1990) proposed that nascent creative talent be identified by focusing on the leisure activities of intellectually gifted or specially talented children. Similarly, Niemi (2015) tracked a large sample of American youth and found that, of all factors investigated (arts participation, SAT scores, diverse psychological traits), only interest in visual arts proved a statistically significant predictor of entrepreneurial behavior. In a study of self-assessed workplace habits and creative practice, Jaussi et al. (2007) and Jaussi and Randel (2014) found that senior managers benefitted from non-work experiences and knowledge, particularly those associated with extra-vocational hobbies and avocation. Not only did workers with avocations tend to report creative identity, those who brought their non-work skills to bear on work projects were deemed more creatively vocationally.

Anecdotal evidence also suggests avocational impact on vocation. Nobel Prize winner Max Planck forged his quantum theory of electrons by treating orbits in the atom as if they were vibrating strings—an exercise dependent on knowledge he acquired as an amateur pianist. Albert Einstein, another Nobel laureate, drew explicit connections between his own musical avocation and the intuitive processes of his scientific creativity. Literature laureate Thomas Mann played violin and piano and otherwise immersed himself in music—his passion for these pastimes affected the style and structure of his novels, particularly in his use of leitmotif. Economics laureate Herbert Simon, who also played piano, was legendary not only for the number of disciplines he pursued vocationally, but the for number of activities he pursued avocationally. In his case, serious hobby seems to have had impact on vocational activity by design: “I can rationalize any activity I engage in as simply another form of research on cognition ... I can always view my hobbies as part of my research” (Simon, 1996, 243).

Vocation can likewise have positive creative impact on avocation. Tolkien funneled his philological interest in languages missing from the historical record into the avocational reconstruction of a mythic “faery” tongue antecedent to Anglo Saxon. The same linguistic interests that drove his vocation also drove his avocation, though eventually Middle-earth became an imaginary world and literary pursuit of its own (M. Root-Bernstein, 2014). Maurice Allais (1989), Nobel laureate in economics, brought the periodicities of physics (which he pursued as a serious amateur, at professional levels) to bear both on his vocation in economics and his avocation in history, an ambitious attempt to draw out regularities in the rise and fall of civilizations. Contemporary visual artist Todd Siler enabled his avocational development of a fractal reactor, well-received in physics circles, with thinking and drawing processes borrowed from his art practice (M. Root-Bernstein, 2014).

As these last exemplars must make clear, the relationship between avocation and vocation is a fluid one. Creative transfer can run in either or both directions. Indeed, for many individuals, the avocation may exert the larger creative pull, such that it eventually supplants the individual’s original vocation and becomes either the sole or a dual vocation. This was true for Tolkien, as it has been for numerous others studied by Root-Bernstein and Root-Bernstein. In some cases, indeed, the avocation is less a “subordinate” passion than it is a choice made between competing vocational options. Planck might have been a concert pianist; Siler loved physics from an early age; vocational opportunity turned Allais from history towards economics. In cases such as these, the avocation does not simply fill in leisure time, but functions to maintain an individual’s multiple interests within an integrated network of

creative enterprise. Because of that integration, the avocation may have its greatest creative impact on the networked vocation. Vice versa, the “normal” practice of a vocation may have its most original and effective impact in an innovating avocation.

Implications for Future Research

In the study of avocations and creativity, much remains to be investigated. Which avocations best support endeavors beyond science? How can cognitive and other benefits of avocation be reliably investigated? How can creative transfers to and from vocation be verified? Answers to these and related questions will require more psychological and sociological study, as well as more historical and biographical case study, tracing the knowledge-making interactions between avocation and vocation for creators of all kinds. At stake is an effective understanding of the role of polymathy, transdisciplinary cognition, and leisure-work synergy in human creativity. How does serious avocation inform current academic debates as to whether creative know-how is innate or learned, specialized or universal? How do educators teach for life-long learning in a world of fast-paced knowledge innovation and obsolescence? Perhaps more than ever, avocations stand as bulwark against the tyrannies of over-specialization in education, the cult of over-work in the marketplace, and the erosion of active amateur activity in a growing sea of passive entertainments. Avocations matter and matter greatly, not just to self-fulfillment, but to socially recognized creativity. Whether personal or public, creativity requires the networking of previously unassociated interests, ideas, and capabilities, along with the drive to take upon oneself the doing, the making, and the solving of cultural challenge. By reducing emotional risk, opening up mental space for playful exploration, and providing autotelic reward for skill development and knowledge transfer, avocations play their part in that process.

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Awards[☆]

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Introduction

Various cultures and civilizations throughout history have used awards to honor those individuals who best represent highly valued achievements. Perhaps the most ubiquitous and conspicuous are the honors received for heroism in military combat. Examples include the French Croix de guerre, the German Eisernes Kreuz, and the US Medal of Honor. Nevertheless, some societies have also chosen to recognize accomplishments more often associated with peace rather than war. Perhaps the most salient examples are the gold, silver, and bronze medals bestowed on the top athletes every 4 years at the Olympic games. Also in this second category are various ways of recognizing major creative accomplishments. The ancient Greeks allotted annual awards to the best plays shown in the Athenian Theater of Dionysius. Multiple winners of these dramatic competitions include the great tragedians Aeschylus, Sophocles, and Euripides.

In modern times the best known awards of this kind are probably the Nobel prizes for literature and the sciences, the latter category encompassing separate honors for physics, chemistry, physiology or medicine, peace and, most recently, economics. The Nobels are international awards, but many countries feature more regional awards. Thus, the United States has Pulitzer Prizes for newspaper journalism (e.g., international reporting, feature writing, commentary, criticism, editorial cartooning, and feature photography), literary achievements (in fiction, drama, history, biography or autobiography, poetry, and general nonfiction), and musical composition. Many other awards recognize specific domains of creativity. For example, the Miguel de Cervantes Prize is awarded to the most outstanding writer in the Spanish language (but not necessarily a Spanish writer). Of a similar nature are the Goethe (German) and Camões (Portuguese) prizes. Most well-established professions will support an appropriate set of honors. For instance, research psychologists can receive the Award for Distinguished Scientific Contributions granted by the American Psychological Association.

The most prestigious awards are bestowed upon creators in impressive gala events. Perhaps the most prominent example are the Oscars given out by Hollywood's Academy of Motion Picture Arts and Sciences in a ceremony broadcast worldwide. Moreover, the recipient might receive the honor directly from the hands of a major celebrity, including royalty. Nobel laureates receive their gold medals directly from the Swedish monarch. At the other extreme, far less eminent honors might be simply announced in a press release or official newsletter.

The first psychologist to use awards to study creativity was Francis Galton in his 1874 *English Men of Science: Their Nature and Nurture*. Galton wanted to study the development factors underlying exceptional scientific achievement so he distributed questionnaires to scientists of sufficient distinction that they had been elected Fellow of the Royal Society of London. Because fellows can only be elected by previous fellows, this group formed a highly elite sample. Among the more than 100 scientists responding to his questionnaire were the mathematician Arthur Cayley, the physicist James Clerk Maxwell, the biologists Charles Darwin and T. H. Huxley, and the evolutionary philosopher Herbert Spencer. Using their responses, Galton was able to show how family background (e.g., birth order) and educational experiences (e.g., dislike for school) can affect the emergence of scientific creativity.

From time to time other researchers have followed in Galton's footsteps, Nobel laureates and Oscar winners perhaps receiving more empirical attention than any other group of awardees. To appreciate why investigators have examined awards let us first

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examine the distinct advantages of this approach. Next we shall review some of the actual applications of awards to the study of creativity. In addition, the use of awards can be compared with closely related indicators of creativity. But an encyclopedia entry such as this would not be complete without discussing potential disadvantages as well.

Advantages

Among the oldest issues in the study of creativity is the “criterion problem.” By what standard do we determine that a person or product is creative? For example, suppose the investigator wanted to study the personality correlates of creative achievement among United States psychologists. One plausible solution might be to use awards and honors as an index of creative achievement in psychology. Such recognition might include election to the National Academy of Sciences (NAS) or receipt of the Distinguished Scientific Contribution Award (DSCA) of the American Psychological Association. Such honors would seem to have a *prima facie* claim to validity. After all, expert peers are almost invariably involved in deciding who receives the honors. Moreover, the recipients must normally undergo a rigorous nomination and evaluation process in which a candidate’s career is assessed with the aid of supporting documentation, often including nomination letters and complete curriculum vitae. It is reasonable to assume that those who have such honors bestowed upon them are more creative than those who do not.

As a consequence, awards and honors provide a potential solution to the criterion problem. Furthermore, such formal acts of recognition have two other assets as criteria variables.

First, they can be used to assess the magnitude of creativity. In many domains of creative achievement, awards and honors can be arrayed in a hierarchy from the most competitive to the least competitive. In psychology, for example, membership in The National Academy of Science (NAS) is more selective than getting the Distinguished Scientific Contribution Award (DSCA). Furthermore, below the latter are the various career achievement awards offered by the many APA divisions, such as the Ernest R. Hilgard Award for a Career Contribution to General Psychology bestowed by the Society for General Psychology (Division 1). Below that award might be one of the more specialized divisional awards, such as the George A. Miller Award for an Outstanding Recent Article in General Psychology (also Division 1). Lower still would be election as Fellow of APA or the Association for Psychological Science (APS). Needless to say, election to NAS does not have to represent the acme of this scale. A true elite has earned a Nobel Prize in either economics or physiology/medicine. Accordingly, we might array the award hierarchy as follows: Nobel, NAS, DSCA, APA divisional career awards, APA divisional “best” publication awards, and APA or APS Fellow status. Hence, award criteria do not have to represent dichotomous either-or measures. Instead, it is sometimes possible to define a rank-category scale.

Second, award criteria measures can be applied to different units of analysis. Some honors are routinely assigned to individual creators, whereas others are allotted to single creative products. Indeed, that contrast was already implied in the preceding paragraph. The Hilgard Award recognizes a lifetime of distinguished contributions, whereas the Miller Award honors a single notable contribution. The distinctions can be made even finer. On the one hand, many professional organizations offer “early career” awards as well as lifetime career awards. For example, APA’s Division of Developmental Psychology annually bestows the Boyd McCandless Award to young promising researchers and the G. Stanley Hall Award to those who are entering the final phase of their careers. On the other hand, some organizations may distinguish between types of creative products to be honored. Besides the Miller, APA’s Division 1 also bestows the William James Book Award. Interestingly, these distinctions may be combined to yield a honor like Division 1’s Gardner Lindzey Dissertation Award – a kind of integrated early career and best product award.

Researchers tend to use award criteria in two different ways. The first is to introduce a specific award or honor as a sampling criterion. This is what Galton did in *English Men of Science*. Only scientists who were Fellows of the Royal Academy were sent questionnaires. The second usage is to sample individuals with and without the award and then define a dichotomous variable that equals 1 if a person received the honor and equals 0 if they did not. As an example, a number of investigators have compared US scientists elected to NAS to those who failed to earn that distinction.

Illustrations

To appreciate fully the value of using awards in creativity research, extended examples are necessary. Consequently, below are overviews of two rather extensive research literature. The first concerns scientific creativity and uses the individual creator as the unit of analysis. The second concerns artistic creativity and uses the single creative product as the analytical unit. The specific topics are Nobel laureates and award-winning movies, respectively.

Nobel Prizes

Alfred Nobel was the inventor of dynamite and a major Swedish armaments manufacturer. Having read a premature obituary that condemned him as the “merchant of death,” and having never married and fathered a family, he decided to use his vast wealth to leave a more positive legacy after his death, which took place about eight years later. In his last will and testament, written about a year before his death, Nobel left a huge amount of money to award contributions to physics, chemistry, physiology or medicine, literature, and peace. The first such awards were bestowed in 1901. A prize for economics was instituted in 1968 and first awarded a year later. Because this award was not part of Nobel’s original will, some observers contest that it does not count as a true Nobel.

Nonetheless, the selection procedures for the economics prize are every bit as rigorous as the procedures for the prizes. Both nomination and selection must meet extremely high standards. For instance, the physics, chemistry, and economics prizes are chosen by five-member committees appointed by the Royal Swedish Academy of Sciences. Nominators are also carefully restricted. It often takes a considerable time for someone eligible for the Nobel to finally receive the honor. For example, Einstein received the prize for physics in 1921. The prize citation specified his work on the photoelectric effect, a contribution he made in 1905. Some potential recipients have even died before they could be appropriately honored.

Some empirical investigators have been content to study the general characteristics of Nobel laureates, often concentrating on some subgroup, such as the scientists or the writers. Although these inquiries can often yield fascinating insights into the constitution of the typical laureate, their value is diminished whenever they lack a suitable comparison group. As a result, the most useful empirical studies will introduce some type of between-group contrasts. These contrasts largely assume two forms: (a) laureates in one domain are compared to laureates in another domain and (b) laureates are compared to non-laureates.

Laureates Versus Other Laureates

Researchers have often scrutinized whether a Nobel recipient in one category differs from a recipient in another category. Some of this work has concentrated on early developmental experiences (e.g., [Berry, 1981](#)). For instance, in comparison to laureates in literature, laureates in the physical sciences are far more likely to have fathers who were academic professionals. Additionally, laureates in literature were far more prone to have lost their father during their minority years in comparison to laureates in the physical sciences.

Other researchers have examined the differential career trajectories of laureates in the various categories. In general, physicists reach their career peak earlier than chemists, who in their turn tend to peak earlier than researchers in physiology or medicine. These differences show up in the ages at which the scientists are most likely to receive their highest honor. Physicists are around 49 years old, chemists about 52, and bio-medical researchers approximately 55 ([Stephan and Levin, 1993](#)). Apparently, Nobel's in economics are bestowed to even older recipients.

The foregoing results imply that the specific nature of creativity varies across the Nobel categories. Creativity in physics has a different composition than in, say, literature.

Laureates Versus Non-laureates

Just as interesting are studies that compare Nobel laureates with non-laureates in comparable disciplines (e.g., [Root-Bernstein et al., 2008](#); [Zuckerman, 1977](#)). These investigations have found the following differences: (a) laureates are more likely to have attended prestigious universities and to have studied under previous laureates; (b) despite a strong commitment to their chosen area of research, laureates are much more likely to have many interests and hobbies; (c) laureates implement cognitive processes that are identifiably different from comparison groups; (d) laureates are more prolific, producing many more publications per year than their less illustrious colleagues; and (e) in comparison to non-laureates, Nobel prize winners move up the academic ladder much more quickly, attaining full professorship at a younger age. These contrasts often hold up even when Nobel laureates are compared to members of the National Academy of Sciences, themselves a distinctive group of scientists. When the comparison group consists of even less distinguished scientists, the contrasts most often become even more dramatic.

It should be noted that far more research is devoted to laureates in the sciences than in literature or peace. Awards in the latter two categories are often viewed as more influenced by political concerns whereas the science awards are seen as more objective. The specific achievements in the non-science awards are also more heterogeneous and controversial. The sciences have the advantage that a much stronger consensus exists on what counts as a substantial contribution to a given domain.

Movie Awards

Nobel's original intention was that the prize recognize specific achievements within one year after their occurrence. At first the prize committee tried to carry out this wish. It was for this reason that Dmitri Mendeleev was denied the prize for chemistry: His famous periodic table of the elements was already too old at the beginning of the 20th century. Nevertheless, the committee soon realized that this restriction was impractical. Time is necessary to obtain sufficient perspective on the magnitude of an achievement. Accordingly, the award is often bestowed long after the original contribution that inspired the honor. Because of the delay, the Nobel often functions as a career achievement award. When Einstein received the Nobel in 1921, the citation said that he was so honored for "for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect." The prize committee knew that Einstein was already better known for his special and general theories of relativity. Sadly, by the time the prize committees began to prolong the period in which eligible accomplishments would be considered, it was already too late for Mendeleev, who died in 1907.

It is interesting, therefore, that awards in the arts often insist on a one-year time window. That is, each award ceremony recognizes the greatest contributions in a given year. Thus, in the United States, the Pulitzer Awards clearly concentrate on the most recent achievements in its various categories. The same time limitation holds for the National Book Awards, all entries having to be published between December 1 and November 30 of the following year. This temporal focus is especially conspicuous for honors in theater and film, which are invariably confined to productions that appeared in a single year interval. Of the film honors, the most famous are the Oscars awarded by the American Academy for Motion Picture Arts and Sciences in Hollywood. But these are far from the only film honors. All told, more than 1500 award ceremonies are currently active, albeit the largest number of these represent local film festivals. The number of high-prestige movie awards is much smaller, and so the bulk of the empirical studies have concentrated on the Oscars alone. That will be the emphasis here as well.

As will be apparent to anyone who has watched a televised Oscar ceremony, awards are offered in numerous categories of cinematic achievement. The biggest honor is that given for best picture, followed by best director, screenwriter (both original and adapted script), the four acting awards – male and female leads and male and female supporting. Less conspicuous, but no less important, are the honors for cinematography, editing, art direction, costume design, makeup, score, song, and ending with the more technical contributions of visual effects, sound effects editing, and sound mixing. Admittedly, not all award ceremonies offer honors in all of these categories. Indeed, some will stick to only the first half dozen or so. Furthermore, some organizations will split one or more categories into more specialized achievements. The Hollywood Foreign Press Association separate Golden Globe Awards into best picture and lead acting awards for dramas and comedies or musicals. Finally, it should be observed that most organizations bestow two levels of honors – the nomination and the outright award. Given the competitiveness of these honors, receiving an “Oscar nod” is deemed no mean achievement, even if it is not followed by an Oscar statuette.

Empirical research concerning these diverse awards leads to two major conclusions (Simonton, 2011):

First, the awards and nominations bestowed by major organizations display a very conspicuous consensus for most award categories. This agreement holds independent of whether the honors are decided by professionals, journalists, scholars, or critics. The consensus is probably surprising given that some organizations presume that their assessments are truly distinct. For instance, the New York Film Critics Circle Awards were initiated as an anecdote to the Oscars, which the East Coast critics thought were contaminated by studio politics and local tastes.

Second, although the inventory of award categories is quite large, certain honors tend to go together. In particular, if we leave aside the best picture award as representing a global honor, then all of the remaining nominations and awards have been shown to form the following four creative clusters: (a) dramatic – consisting of directing, writing, editing, and acting; (b) visual – cinematography, art direction, costume, and makeup; (c) technical – visual special effects, sound effects editing, and sound mixing; and (d) musical – score and song. Notably, these four clusters do not all correlate in the same way with a film earning the best picture award: the most prominent correlation is for the dramatic cluster, followed by the visual cluster, with only one tenth the effect. The technical and musical clusters, in contrast, are not associated with best picture honors. In other words, great cinema seems to require pretty much the same aesthetic assets as great theater, namely, drama and visuals. Special effects and music are optional. Just as significant is the fact that these four clusters exhibit different correlations with other variables associated with cinematic creativity, such as production budget and screenplay attributes (See FILM).

Disadvantages

Although award measures have proven useful in research on creative persons and products, such assessments are not without problems. One drawback is that they are clearly confined to the highest levels of creativity – what researchers often style “Big C” Creativity. Everyday “little-c” creativity does not receive conspicuous recognition. At best, such creativity might earn some localized praise, such as someone getting “employee of the month” for a particularly imaginative and useful recommendation placed in the company “suggestion box.” Moreover, even in the population of exceptional creators, certain honors have rather low base rates. At present, a little over 100 writers have received the Nobel Prize for Literature since its inception. When one considers that these writers represent every major literary language and hail from every continent except Antarctica, it is clear that the vast majority of highly creative writers will never receive this award. Although many of these will be recognized by more regional awards – such as the Cervantes, Goethe, and Camões prizes – it remains the case that award winners form an elite at the uppermost tail of the creativity distribution.

Even worse, the history of any award will be embarrassed by certain numbers of false positives and false negatives. The former represent cases where someone received the honor even when he or she was undeserving. This was a principal reason why the Nobel Prize committees now ignore Nobel’s stipulation that the awards go to recent contributions. Even then, the awards sometimes go to the wrong recipients. When it was initially announced that the 1923 Prize in Medicine would go to Frederick Banting and John Macleod for the discovery of insulin, Banting protested that it was Charles Best rather than Macleod with whom he should share the honor. Banting almost refused the award, and when he finally consented, he shared half of his prize money with Best. According to Banting, Macleod’s sole contribution was to provide some laboratory space for the experiments that Banting and Best conducted.

False positives also happen in the case of awards for creative products. Film critics and historians are fond of pointing out the best picture Oscars that went to the wrong film in a given year. In 1953 Cecil B. DeMille received the best picture award for *The Greatest Show on Earth* when the other four nominees were *High Noon*, *Ivanhoe*, *Moulin Rouge*, and *The Quiet Man*. All but *Ivanhoe* are now considered much better films.

False negatives occur when a deserving person or product fails to receive the appropriate recognition. The history of the Nobels contains many examples of great creators who never received the honor. The literary prize, especially, has snubbed many notables. The false negatives include W. H. Auden, Jorge Luis Borges, Karel Čapek, Henrik Ibsen, James Joyce, Franz Kafka, André Malraux, Vladimir Nabokov, Marcel Proust, Leo Tolstoy, Mark Twain, and Émile Zola. In the early years great writers were often overlooked because of an excessively restrictive application of Nobel’s will (which might be taken to imply that the work should be idealistic), but later literary creators were often passed over for political reasons. Also, political factors have probably introduced some false positives among the literature laureates.

With respect to the science Nobels, many false negatives ensue from the requirement that the award not go to more than three persons in a given year. Notwithstanding this provision, some awarded achievements should have been credited to four or more

scientists. A case in point is the 1965 Nobel Prize for Physics that was bestowed on Richard P. Feynman, Julian S. Schwinger, and Sin-Itiro Tomonaga for their work on quantum electrodynamics. This left out Freeman C. Dyson, who had made the important contribution of showing that their independent formulations were actually equivalent.

False negatives are particularly likely when an achievement has a narrow time window for eligibility. Because Oscars are only given to cinematic achievements in a single year, the Academy cannot carry over an achievement to the next year if there are too many deserving nominees in a given year. Peter O'Toole was nominated 8 times, most recently in 2007, but only received an Honorary Award not associated with a specific cinematic achievement.

Ironically, the existence of false negatives can sometimes produce false positives. If someone in the film industry repeatedly received an Oscar nod without any ultimate success – always a bridesmaid never the bride phenomenon – then a “sympathy vote” may emerge that will award a person for an accomplishment that does not represent his or her best work. Martin Scorsese was unsuccessfully nominated for best director 5 times before receiving it on his sixth nomination, in the latter case for a lesser directing achievement and against some rather stiff competition.

The last illustration shows that awards can often be subjected to various contaminating influences that can partly undermine their validity. To offer another example from the realm of film, a picture nominated for a best picture Oscar will improve the chances of awards for those involved in making the film, particularly the high-profile directors and actors. An even more striking example is seen in those international piano competitions where the order of each pianist's performance is determined by chance. Those who perform first are at a disadvantage relative to those who perform later. In this case, success is literally a matter of the luck of the draw.

Apart from the above problems, award indicators often have limited applicability. Not every domain offers suitable awards, or at least comparable awards. The divisional awards offered by the American Psychological Association provide a good example. There are more than 50 divisions, most (but not all) offering one or more awards. Yet there is no consistency in the number and type of awards. Naturally, some of this inconsistency can be ascribed to the fact that some divisions emphasize pure research whereas others emphasize practice or application. Yet even among the research-oriented divisions, there is no consensus on what achievements to include in the award programs. The division for developmental psychology has an early career award, whereas the personality and social psychology division does not. The experimental psychology division has an early investigator award, but the winning publication has to appear in the *Journal of Experimental Psychology*. Some divisions have dissertation awards, and others do not. And so forth. This means that it would be next to impossible to use division awards to assess creative achievement in American psychology. Whether or not a given psychologist won an award would partly depend on his or her subdiscipline.

Comparisons

Given the measurement problems that can confront application of award measures, one should consider the use of alternative but comparable measures. At the very least, these alternatives can be used to crosscheck the award assessments. In any case, the alternatives differ depending on whether the unit of analysis is the product or the person.

Creative Products

The optimal manner to assess the differential creativity of separate products is often contingent on the domain of creative achievement. In the case of the sciences, many studies rely on the number of citations a given publication receives in the professional literature. Such citation counts have the advantage in that they are less selective. It is less demanding to publish an article or book that is cited by others in the field than to have the publication win a major award. Furthermore, because award-winning work is not necessarily highly cited, citation counts can provide an independent assessment of a product's impact.

In the arts, citations are less meaningful as indicators of quality, and so alternative measures are necessary. For example, the creativity of musical compositions can be gauged by the frequency of performance or recording. This approach has been used to evaluate the differential aesthetic success of plays as well. In the case of poetry, an indicator might consist of the number of times a particular poem is included in various anthologies or how often lines from that poem are quoted in compilations of great quotations.

There is one assessment technique applicable to both artistic and scientific products: expert evaluations. A most obvious example is the judgments of professional critics. As noted earlier, the evaluations of film critics have been shown to correlate with nominations and awards received in the dramatic cluster. Critical evaluations are available for many other art products, including theater, fiction, music, and even video games. In a slightly different form, the same approach can work for scientific products. In this application, experts are asked to evaluate journal articles or monographs. For example, some journals have their own “best article” awards in which members of the editorial board are asked to evaluate various nominees. Curiously, one investigation showed that the articles so honored did not exhibit higher citation rates than those not so honored. It is likely that judges require a longer time perspective than just focusing on the publications that appeared in the most recent annual volume.

Creative Persons

If the goal is to assess persons rather than products, then some of the preceding approaches can be carried over with only minor modifications. Certainly, expert evaluations can just as well be applied to individuals. In fact, such assessments were introduced early in the 20th century by James McKeen Cattell [See GENIUS AND GREATNESS]. Most commonly numerous experts in a particular domain are asked to identify the top contributors to the field. These survey results are then consolidated into a single ranking or rating. In the sciences, citation counts can be implemented, only in this case the citations involve a creator's total output rather than a single publication.

Two other measurement strategies are unique to individuals.

First, creativity can be assessed in terms of productivity, especially total lifetime output. Of course, the specifics of what is counted depend on the domain creative achievement: patents for inventors, journal articles for scientists, films for directors, etc. If the creative domain entails a diversity of products that cannot all be treated equally, then some kind of weighting scheme is applied. For example, in assessing the productivity of composers, more weight must be assigned to a symphony than to a song. Finally, if the creators under investigation are still alive, then some adjustment must be introduced for age. On the average, older creators will have accumulated more output than younger creators.

Second, creativity can be gauged according to eminence [See EMINENCE]. Typically, this might entail a measure of the amount of space devoted to each creator in standard reference works, such as encyclopedias and biographical dictionaries. To maximize reliability, these space measures should use as many sources as possible. In addition, it is often necessary to implement corrections for certain biases that sometimes intrude on such measures. For instance, reference works often devote more space to literary figures and to visual artists. Research has shown that the differential eminence of creators tends to be relatively stable over time, even across centuries. The most famous painters in the Italian Renaissance remain famous today.

Citation, productivity, and eminence measures invariably exhibit highly skewed distributions with a long upper tail. Award-winning creators are most likely to be found among the individuals in that tail. In fact, citation counts have even been used to predict recipients of a Nobel Prize. Unlike award measures, however, citation, productivity, and eminence measures can discriminate creators at the lower end of the distribution – the individuals who will never earn any major awards.

Integration

Major awards and prizes can provide widely accepted evidence of the highest-level creative achievement. Although the most celebrated awards have very low base rates, these can be combined with lesser honors to create an ordinal scale. Better yet, this scale of acclaim can be integrated with continuous measures, such as eminence and productivity, to generate a composite indicator that covers the full range of what has been called “Big-C Creativity.” Indeed, it is even possible to extend the measurement down to the lower reaches of “little-c” or more everyday creativity [See EVERYDAY CREATIVITY]. This possibility is partially realized in the Creative Achievement Questionnaire (CAQ; Carson et al., 2005). Respondents are first asked to identify the areas in which they have somewhat more “talent, ability, or training than the average person.” The specific domains are visual arts (painting, sculpture), music, dance, individual sports (tennis, golf), team sports, architectural design, entrepreneurial ventures, creative writing, humor, inventions, scientific inquiry, theater and film, and culinary arts. Then for each of these areas the respondents address a series of questions that define an 8-point scale, with 0 indicating the absence of any talent. Beyond this zero point are inquiries about low-level creativity, such as taking music lessons or having performed in a play. Higher up come more demanding criteria, including publication, shows, grants, critical reviews, citations, and special prizes. Although the awards are designated as local or national, it would certainly be possible to add a higher point on the scale to allow for the receipt of international awards, such as a Nobel or an Oscar. Such an extended version of CAQ would then span the complete spectrum of domain-specific creativity, from none whatsoever to the highest imaginable.

It is hoped that someday awards will be incorporated into such an inclusive measure of creative achievement. CAQ scores have been shown to correlate positively with alternative indicators of creativity, such as divergent thinking and creative personality [See DIVERGENT THINKING; PERSONALITY]. Such scores also correlate with other dispositional traits that are independently correlated with creativity, such as openness to experience and defocused attention. Therefore, high-prestige awards can be used to discern whether these same correlates help account for some fortunate creators managing to receive the highest levels of recognition. To illustrate, does a Nobel laureate differ from a Fellow of the National Academy or Royal Society in the same way that the latter differ from a scientist who received lesser honors? It is conceivable that a single psychological continuum connects the lowest levels of creativity with those that are the most universally acclaimed.

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Behavioral View of Creativity

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Glossary

Insight A solution that seems to arrive suddenly, in an a-ha moment, but is actually the result of a protracted process.

Intrinsic Motivation An interest in something that comes from within the individual rather than outside of the individual. In the operant view experience with reinforcers in one's past can lead to what appears to be intrinsic motivation but instead is due to "reinforcement history."

Learning In the operant view learning occurs when behaviors change. This occurs when consequences (reinforcers or punishers) are associated with particular voluntary behaviors, or operants.

Let-it-happen A kind of tactic where the individual focuses elsewhere and thus allows certain preconscious processes to contribute to the creative process.

Make-it-happen A tactic where the individual directs thinking and intentionally works through a method for finding creative ideas.

Operant A voluntary behavior, intentionally emitted to earn a reinforcer or avoid an avoid a punisher.

Shaping The method of successive approximation which can be used to teach new behaviors.

Spontaneous Integration An explanation for insight which points to the coming together of previously learned responses but discrete into one seemingly new insightful behavior.

Introduction

In one sense it may come as a surprise that the behavioral view of creativity owes much to B. F. Skinner. After all, Skinner is known to have focused on observable behaviors. A careful reading of his work shows that he did not really think that other things (not easily observed nor measured) were unimportant. Rather, he felt that they were outside of the realm of the sciences. He was interested in predicting and controlling behavior and felt that if you could not do both of these things, the explanation of behavior was unscientific.

Late in his career he worked with Robert Epstein on a series of fascinating studies focused on topics that, at first blush, might not seem to be under the umbrella of behaviorism at all. They examined self-concept, for example, and insight. The work on insight is quite relevant to theories of creativity. A number of theories look to insight and to the a-ha experience that sometimes indicates a creative breakthrough (e.g., Gruber, 1981; Wallace, 1991). Skinner and Epstein had a behavioral explanation for insight. They were able to predict and control it.

This research offers another surprise: they worked with pigeons. They not only predicted and controlled insight, but they did it in a species with a puny brain (and cortex-to-body ratio).

It is easy to summarize the work of Skinner and Epstein on insight: Pigeons first had their wings clipped so they could not fly. They were then "conditioned" to recognize pigeon food which was shaped and colored to look like a banana. Why a banana? Because this research in many ways followed that of Hans Kohler, who worked with the famous ape Sultan. And of course apes like bananas. Kohler used banana as reinforcement for Sultan.

Sultan needed no conditioning to recognize a banana as reinforcement. In one experiment Kohler placed a banana outside of Sultan's cage and just outside of Sultan's reach. As you can imagine the cage had bars, and Sultan held on to those bars and spied the banana. But he did not use trial-and-error to discover how to reach the banana. This was Kohler's breakthrough, described in *The Mentality of Apes* (1925). It made him famous for he showed that a subhuman species could think in a fashion that did not depend on trial and error. He demonstrated that apes can think insightfully. Sultan's insight was apparent in that he looked at the banana outside of the cage. If he used trial and error he might have gone over to a wooden crate that was in his cage and tried to fit it through the bars to reach the banana. He might have tried his left arm and then his right, and then his left again. He might have tried the tire that was in his cage, as a toy, and then the Samsonite luggage that would someday be used for a commercial, to show how tough luggage should be. Sultan did none of this. Instead he looked at the banana, then looked around the cage—and spotted a stick. He looked at the banana again, and then grabbed the stick and used it to extend his reach and was able to bring the banana close enough to grab and eat. He was of course reinforced for this by the banana itself. Most importantly, there was no trial and error. Just an insight.

In a second experiment Kohler hung a banana from the bars that made up the ceiling of the cage. The banana was again out of reach. Sultan had a problem: how to get to the banana? This time he stood below the banana and looked up. Once again he did not use trial and error and did not try the tire, the stick, nor the luggage. Instead he looked at the banana, looked at the crate nearby, looked at each again, and then moved the crate, jumped on top of it and was able to reach the banana. He was again reinforced by eating a banana, and again there was no trial and error.

Apes are not dissimilar to humans. They are mammals and have large brains. They have a respectable cortex-to-body size ratio. It was a big deal in 1925 that Kohler showed a subhuman species to have the capacity for insight, but it is not a big deal in 2020. Indeed, such sophisticated problem solving has been seen in other species, including elephants and otters. But birds?

Skinner and Epstein conditioned pigeons to solve the banana problem. They proposed that what looked like an insight—a sudden a-ha solution—was actually an integration of previously learned “operants.” These are simply behaviors that operate on the environment to obtain a reinforcer or avoid a punisher. With this in mind Skinner and Epstein conditioned a pigeon to eat pigeon chow that looked like a banana. That probably was not so difficult because it was, after all, pigeon chow.

Next they conditioned a pigeon to push a small crate-like object around the cage. This was a bit more time consuming, but not much. Shaping was used. This is the method of successive approximations, where one behavior, which is in the organism's existing repertoire, is reinforced, so it occurs again. And again. And again. For the pigeons this was probably something like looking at the small crate. Once they did that reliably, a new approximation was required: moving towards the crate. That was reinforced for a while, until it was reliably emitted. Then they had to touch the crate to earn chow, and eventually they had to pick up the crate (using their peaks) and then stack one crate on top of another. All of this was done discretely in the sense that only one behavior was reinforced at a time. If the pigeon was reinforced for stacking the little crate, the pigeon was not reinforced for anything else (e.g., merely looking at the crate or merely pushing the crate). This was a critical aspect of the research: only discrete behaviors were reinforced, one at a time. The chain of behaviors (looking, then approaching, then pushing, then stacking) was never reinforced.

This is important because that “spontaneous integration of previously learned responses” is what constitutes the insight. And indeed, when the pigeon was placed in the cage with the banana-shaped chow hanging from the ceiling it basically did what Sultan did. Look at the banana, look around the cage, look at the banana, look at the crate, and boom—insight. The pigeon integrated the discrete responses and approached, pushed, and stacked the little crate, hopped up and ate the banana shaped chow. One behavioral interpretation of this is that there is no need to attribute this solution to insight. It can instead be attributed to previous experience and, when needed, the spontaneous integration of previously learned (discrete) responses, each of which was learned via shaping and reinforcement.

Insight is not creativity, and pigeons are not humans. Still, this work exemplifies the behavioral idea that highly objective methods, focusing on observable behaviors (operants), can explain much, including some things that are relevant to some creative breakthroughs.

There is much more to the behavioral approach. One intriguing idea that was not in Skinner's experimental work can be found in his suggestions for scientists (e.g., “A Case Study of the Scientific Method”). It which to imply that intrinsic motivation was important in his career. He wrote, “when you run into something interesting, drop everything and study it” (p. 223). Note that Skinner did not refer to intrinsic motivation, and in fact one very clear message that comes across when his work is read is that language must be precise. In research it should be operational.

The Big Problem: Explaining Originality

One of the biggest problems in creativity research involves explaining originality. This is critical because originality seems to be a prerequisite for creativity. The standard definition of creativity, for example, requires that creative things are original and effective. Both of these terms may vary some, originality sometimes being called novelty, for example, and effectiveness sometimes called utility, relevance, aptness, or value.

Are humans even capable of originality? This question is rarely asked, but it is occasionally implied. It arises with certain definitions of creativity. In quite a few of these creativity is defined as a combination of existing mental elements, in which case the result

is not really new and original but is instead just a new combination of what existed before. Then there is the view that everything we think is in some way tied to what we have thought before. This line of thought often points to analogies, and certainly many creative things have been found using analogies. The steam engine is often described in this way, for example, as is Velcro. At the extreme the use of analogies also implies that what is viewed as creative is not entirely original but is based on what is already existing. This question of originality is implied by the behavioral view. Think back on the spontaneous integration of previously learned responses. The only original part there is the integration; everything else already existed.

A rebuttal to the question of behavioral originality may be found in work with yet another subhuman species, namely the porpoise. In this work, reported by Pryor, Haag, and O'Reilly (1969), porpoises were conditioned (and presumably reinforced with fish). The porpoises were not, however, conditioned towards any one particular solution to any one particular problem. They were instead conditioned to emit leaping and swimming behaviors that they had never done before. In this manner they were reinforced for novel behaviors, not mere recombinations. Recall here that novelty is often a synonym for originality. This research demonstrated that novel behaviors could be learned, increased, and controlled.

Research With Humans

Research not long after that of Pryor et al. used a similar method with children—and demonstrated that they could also emit novel behaviors. And in this research the children were reinforced for novelty in one domain (e.g., finger painting) and the novelty generalized to other domains (e.g., block building). This is critical because a second question sometimes leveled at the behavioral approach concerns generalization. That may be defined as the degree to which something learned in one setting (e.g., the laboratory) is later expressed in another setting (e.g., the natural environment). The research with finger painting and block building demonstrates that generalization can be brought under operant control.

Other relevant work includes a series of studies, many with Sidney Parnes as one of the authors, and used behavioral methods with human students. This research is directly relevant because the outcome measures included tests of divergent thinking, and these may be the most commonly used measure in the creativity research. Divergent thinking tests are reliable estimates of the potential for creative thinking. They are not synonymous with creativity, but no test is, precisely because tests sample behavior and therefore are not equivalent to what occurs in the natural environment.

Research with students used a method developed by a student of Skinner's. His name was Fred Keller and he made a name for himself with the Keller Method of Instruction. That method extended behavioral concepts to teaching. It allowed individualized instruction where students work at their own pace, with clear feedback (reinforcement), and, very importantly, unit mastery. The last of these means that students do not progress from one unit or one small section of the material until they have mastered it. Mastery may be 95% on a quiz, or a bit lower, but it is always a very high criterion, which is why the label "mastery."

The results of this work, using Keller's extension of Skinner's behavioral principles, were quite clear. Students in the experimental groups which received instruction via the Keller method outperformed a control groups on various indicators of creative potential, including those based on the divergent thinking tests. No improvement was seen in a personality measure of creativity, but this was easy to explain: personality traits are known to be stable and thus not sensitive to short-term training or enhancement efforts. Divergent thinking, on the other hand, can be improved with short-term training, and the Keller Method showed improvements in the ideation that is targeted by divergent thinking tests.

The Keller Method was not developed by Skinner himself, and in fact quite a bit of the work reviewed earlier in this chapter focused on insight was conducted by Robert Epstein, not Skinner. Yet Skinner had an interest in creativity. That is evidenced by much of his early work, including "The alliteration in Shakespeare's sonnets" (1939), "Has Gertrude Stein a secret?" (1934), and "The psychology of design," (1941). These three essays were examined closely by Runco in a 2019 volume that focused on individuals who influenced the field of creativity before 1950. Here it will suffice to say that Skinner held a keen interest in creativity, and for that reason studied artists (e.g., Shakespeare and Gertrude Stein) and the artistic process. His behavioral inclination is very clear in his essays about those artists. And importantly, Skinner himself dabbled in the arts. His work of fiction entitled *Walden II* is still in print.

Before leaving the topic of the arts and artists there is one more behavioral perspective that should be noted. This was Skinner's explanation for the "starving artist." Critics of behaviorism pointed to starving artists (i.e., artists who invest their time into their art even without monetary reinforcement) as a situation where behaviorism failed. After all, starving artists are not paid and not reinforced and yet they continue to emit the (artistic) behavior. Skinner's rebuttal was that the artists had a reinforcement history that led them to invest in the art. Thus there was something in their past, where they were reinforced for art, and so even though they are no longer reinforced in the present, they continue to display the behaviors and produce art. This kind of thinking is a part of behaviorism; it explains how certain behaviors generalize or are maintained. In operant theory behaviors can be conditioned with particular reinforcement schedules so that behaviors no longer actually need reinforcement, or at least not every occurrence of the behavior. Intermittent reinforcement, for example, is given once in a while, and not in a predictable way, but since once in a while it is associated with a particular behavior, organisms learn to emit the behavior over a period of time, even without regular reinforcement. Playing a slot machine and video games may be explained in this fashion, as can fishing. They are intermittently reinforced. Maybe the arts can too.

Final Comments

This entry reminds readers that Skinner's research on behaviorism and operant psychology is still used. It is easy to see how certain behavioral ideas might be applied to creativity. Admittedly the term creativity may not align well with operant thinking, which is why there was research on insight and novelty, if not creativity per se.

One very important assumption about the operant perspective is that organisms emit behaviors in order to earn or avoid consequences (reinforcers or punishers). When it is a human, there is a decision involved; certain behaviors are chosen. This is quite important because there is also a line of thinking in the creativity research which emphasizes decision making and choices. In that sense it should not be surprising at all that certain ideas from the behavioral school of psychology apply to the study and understanding of creativity. Admittedly creativity is not yet accurately predicted and controlled, which were the goals of B. F. Skinner, but progress is being made.

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Bipolar Mood Disorders[☆]

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Glossary

Bipolar mood disorders A group of related mood disorders described in the American Psychiatric Association's *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition, (DSM-V) (2013). These can be serious, but they are also often effectively treated. Bipolar disorders are characterized by the presence of an episode of unusually elevated mood, but they typically also involve episodes of depression; these episodes of high and low mood frequently alternate with periods of normal mood. Several types of bipolar mood disorders can be distinguished. Bipolar disorder (sometimes termed bipolar I disorder), formerly termed manic-depressive disorder, is defined by a history of one or more episodes of mania – a severe mood elevation that can be euphoric or irritable but causes serious adverse consequences for an individual, such as becoming psychotic, having to be hospitalized, or experiencing severe occupational or social impairments. Hypomania involves an unusually expansive or irritable mood but is milder than mania. Bipolar II disorder involves episodes of severe depressions, along with one or more episodes of hypomania. Cyclothymia is a chronic disorder in which the person experiences many episodes with hypomanic symptoms, as well other episodes with depressive symptoms that are less severe than in bipolar I or II disorders. Bipolar disorders run in families. A familial liability to bipolar disorder is manifested in a wide range of psychiatric syndromes, from mild to severe. Liability is manifested more frequently as depression than mania. A person who carries liability may not even experience symptoms (although subclinical manifestations, including mood elevations, have been postulated).

Compensatory advantage A biological model of inherited disorders for which a psychological parallel has been suggested. In biology, there are inherited liabilities that run in families and not only increase vulnerability to illness, but are also tied to positive characteristics that run in the same families. An example is sickle cell anemia, a recessive genetic disorder in which individuals who inherit a copy of a mutant gene from both parents experience serious, often fatal, medical complications. However, individuals who inherit only one copy of the mutant gene usually have relatively mild symptoms, and these carriers of the gene gain an important compensatory advantage resistance to malaria. A compensatory advantage involving enhanced everyday creativity has been suggested in connection with genetic liability for bipolar disorder. Research in Iceland and Sweden has found that variants of certain genes are associated with both increased risk for schizophrenia and increased creativity. This suggests that variants of some genes that increase liability for schizophrenia also may have a compensatory advantage: an

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association with increased creativity in mentally healthy individuals. The research also suggested a possible analogous finding for genes in bipolar disorder (see Keller and Visscher, 2015).

Eminent creativity This term applies to outstanding creators or creative accomplishments where recognition has been given by society or by relevant professional organizations in forms such as prizes, awards, honors, or publication. The quality of originality or novelty is generally part of what is recognized. Eminently creative individuals and their accomplishments are thought to have exceptional qualities or importance in their cultural context.

Everyday creativity This term applies to creators or creative accomplishments that involve day-to-day activities at work or leisure and are characterized by both originality (involving new and unusual aspects) and meaningfulness to others (rather than being completely random or idiosyncratic). Many types of activities qualify, and they can be concrete products, behaviors, or ideas. The creativity has more to do with how a task is done than what it is called. For example, while the painting of a scene would typically involve significant creativity, it may not if it simply involves following 'paint-by-number' instructions. Everyday creativity can be expressed in a variety of activities, including, for example, making home repairs, designing children's activities, reorganizing an office, counselling a friend, doing gourmet cooking, or charitable work – so long as the activities involve significant originality and are meaningful or adaptive.

Inverted-U effect This phenomenon refers to a curvilinear relationship between two variables, in which both high and low levels of a predictor variable are associated with lower levels of the outcome variable, whereas an intermediate level of the predictor variable is associated with the highest, or optimal, level of the outcome variable. Some research suggests that certain psychological characteristics related to bipolar liability, when they are neither too strong nor too weak, may be associated with higher creativity, showing an inverted-U relation between bipolar liability and creativity.

Unipolar mood disorders Unipolar disorders are characterized primarily by periods of unusually low mood, usually alternating with periods of relatively normal mood. Adverse effects of depressed mood on other psychological functions are also typically present, such as disturbances in sleep, appetite, and energy. These mood disorders can range from major or severe depressions to milder ones, and these milder forms can sometimes take the form of more pervasive or long-lasting dysthymias that involve dysphoric mood. These disorders can be extremely serious, but effective treatments for them are often available.

Introduction

Throughout history, one finds the notion of a link between creativity and psychopathology, going back to pre-Grecian myth and Plato's divine madness. As will be discussed, there is scientific support from recent research for this long-standing belief in an association between increased creativity and psychological disturbance. Particularly among eminent creators in the arts, there are very high rates of major mood disorders, both bipolar and unipolar. This evidence from recent research fits with the findings of older studies. Among eminent creators in non-artistic fields, however, the patterns of relationships involving mood disorders are more complex.

In studying everyday creators, researchers have tended to start with samples of subjects chosen for clinical reasons rather than their creativity. This is a key difference from the research design used in studies of eminent creators, as will be discussed. Research evidence to date also supports the presence of a significant advantage for everyday creativity – for originality in everyday life – in individuals with a personal or family history of bipolar disorders. The most creative individuals may not themselves be the most severely disordered, in accordance with an inverted-U hypothesis of the relation between creativity and liability for bipolar disorder. The most creative person in a family with bipolar disorder may often be one who is psychiatrically normal. In the latter case, what may be important is not the presence of psychiatric symptoms in a particularly creative person, but rather some positive and subclinical psychological traits that run in the families of people with bipolar disorder.

Research findings suggest the optimistic view that a creative advantage associated with liability for bipolar disorder is not directly linked to the pain and suffering that can accompany mood disorders, but rather to a more positive psychological factor. Moreover, some research raises the question of whether there are creative advantages that, in themselves, may heal or even protect against development of full-blown mood disorders. Further work on this issue is needed. These issues are important because of the sheer numbers of people affected by mood disorders. By some estimates, as much as 4%–5% of people in the general population may end up developing a 'bipolar spectrum disorder,' ranging from rather mild to quite severe in degree. If each affected person has even one non-mood-disordered relative carrying a familial risk, as much as 10% of the population could have a heightened potential for everyday creativity and its benefits.

Finally, a note of caution is in order. We are discussing some serious and painful mood disorders, including major depressions and bipolar disorder. It is important not to romanticize these disorders just because creativity might at times be involved. The problems associated with these disorders are severe and often life-threatening. Without treatment, roughly one out of five people with a bipolar disorder will end up taking his or her life. This outcome is particularly tragic, given that treatment can often be highly effective. Furthermore, it appears that treatment may often increase creative potential and achievement. Treatment options should be carefully investigated by anyone who has, or is at risk for, a mood disorder.

Spectra of Mood Disorders

Mood swings appear to fall along a broad continuum of severity. At some level, they may even affect many people in the population at large, as found in one clinical study in which 40% of the control group showed cyclical mood swings that were milder but similar in periodicity to those of a clinical sample. Another major study found that during colder months of the year a great many people suffer at least a few minor symptoms of winter blues or seasonal affective disorder.

Traditionally, there are two broad classes of mood disorders: major depression and bipolar disorder, estimated by some studies to affect roughly 5%–10% and 1% of the population, respectively. Even here, though, there are further spectra, which range into milder variants. The underlying risk for mood disorders displays a strong genetic influence, as shown by the results of adoption and twin studies. However, there is also a large (but poorly understood) environmental component. Bipolar risk or liability involves a more marked genetic component than does risk for unipolar depression. In fact, research suggests implications for enhanced creativity in the relatives of persons with bipolar disorders, even including the psychiatrically normal as well as the unipolar depressed relatives of people with bipolar disorders. Hence, it is important to consider both personal and family psychiatric history.

In defining mood disorders, one should note that there are many more features required for diagnosis than the few given here; these features are listed in the *Diagnostic and Statistical Manual*, fifth edition, (DSM-5) (2013), of the American Psychiatric Association. In a family at risk for bipolar disorder, depressive manifestations can range from dysthymias and milder depressions to severe major unipolar depressions (all of these can occur without a history of clinically significant periods of mood elevation). As noted in the glossary, there are bipolar disorders of varying severity. These include bipolar I disorder, bipolar II disorder (which involves milder mood elevations alternating with episodes of severe depression), and cyclothymia (which involves milder mood swings that may be rapidly alternating). Especially in bipolar I and II disorders, there may be long periods of normal mood between such mood swings. A smaller number of individuals in families with a history of bipolar disorder may show ‘schizoaffective’ disorders, which are characterized by the presence of psychotic features, such as hallucinations and delusions, that occur when the person is experiencing episodes of mania or depression. In summary, a bipolar liability can be manifested in a variety of ways.

The course of mood disorders can also vary dramatically, in both quality and quantity. For example, some people may have only one episode of depression in their whole life, whereas others may experience dozens of depressive episodes. In addition, some people with mood swings may also spend a great deal of their time in a state of relative euthymia, or normal mood. Thus, most individuals with mood disorders do not have an ongoing chronic and unchanging depressed or manic state – a factor that may be important to creativity. Both temporary psychological state factors and ongoing trait factors may be significant.

Bipolar–Unipolar Disorder Distinctions

At this time, research is more plentiful on creativity in families with bipolar compared to unipolar disorders. It is worth repeating that pure unipolar depression is an even more common outcome in individuals with a bipolar family history than are bipolar mood swings, and that such depression may also predict for creativity. One preliminary study suggests, for example, that creativity may be higher in depressed patients with bipolar disorder in their family than in depressed patients without this family history. Perhaps there are subtle and subclinical factors operating – even ones that are adaptive and positive – beyond the more debilitating symptoms. This issue needs careful study. Clinicians can be so intent on sniffing out psychiatric illness and dysfunction that they fail to notice when something is going right, such as unusual creativity.

The several sections that follow concern issues of (a) eminent creativity and mood disorders; (b) everyday creativity and mood disorders; (c) mood disorders, creativity and evolution; (d) biological models in which illness and health may be intertwined; and (e) conclusions and recommendations, including some optimistic implications for fostering creativity potential as well as for better treatment and prevention of mood disorders.

Eminent Creativity and Mood Disorders: Considerations

There is evidence for an association between creativity and bipolar disorders, but the answer depends upon the way the question is asked; see, e.g., Richards (2010) for more discussion of this point.

Defining Creativity, Defining the Question

People often identify creative outcomes using a minimum of two criteria involving (a) originality and (b) meaningfulness to others (as opposed to randomness or idiosyncrasy). With eminent creativity, there is the additional criterion of social recognition of the creative activity – the achievements and their creator have been recognized and won acclaim, either from society at large or from people in particular fields or subpopulations. Many people think of creativity largely in terms of people with eminent accomplishments – for example, the novels of the best-selling authors, the discoveries of Nobel prize-winning scientists, or paintings that went for millions at an auction. Such creators, or creativity, should have some different ingredients from those associated with everyday creativity.

A critical caution: the question one asks helps determine the answer. The results of research depend on whether one is studying (a) eminent versus everyday creators; (b) people chosen for mood disorders rather than their creativity (the second can be an overall

better-functioning group); (c) patterns across families versus within individuals (in families one can find examples of both unusual creativity and mood disorders, though not necessarily in the same person); or (d) a particular field of endeavor (e.g., the arts versus the sciences).

Elevated Rates of Bipolar Disorders in Eminent Artists and Writers

Several modern studies of artistic creativity and mood disorders are notable because they provided more solid support to a range of older and less rigorous studies that pointed in the same direction. For example, in the study by Andreasen (1987) of 30 well-known creative writers who were teaching at the renowned Iowa Writers Workshop, a remarkable 80% had a history of a major mood disorder (compared to 30% of controls). In addition, over half of those affected had a form of bipolar disorder, and a little over half of that number had a history of a bipolar II disorder, showing milder mood elevations.

Supportive evidence was obtained by Kay Jamison (1989), who asked 47 highly distinguished British artists and writers if they had been treated for a psychiatric disorder. A full 38% said that they had been so treated, with mood disorders again highly prominent. These percentages are almost certainly under-estimates of the rates of mood disorders in these eminent creators, because only about one out of three mood-disordered persons currently tends to seek help at all (a particularly sad fact, given the efficacy of treatment). Furthermore, a full 89% of these eminent persons had had intense creative episodes (of a modal length of two weeks), which showed many of the symptoms of clinical hypomania. Finally, these rates may be compared to the lifetime prevalence of bipolar and unipolar disorders in the population at large, which are substantially lower, in the range of 1% and 5%–10%, respectively.

These results support findings from a range of older studies' findings from the 19th century to the early 20th century, which also indicated a creativity–psychopathology connection, particularly in the arts, where most of the work had been done. Despite varied research design flaws, these older studies tended to point in the same direction, supporting a connection between artistic creativity and psychopathology, particularly mood disorders. See review by Richards (1981).

Research on Scientific Professions

An older study that included scientists showed them to be a healthier group than artists on average, with nonpsychotic disorders only about half as common as in artists. More modern research supports this conclusion, including Ludwig's finding that across 18 occupational groups, there was a much healthier picture for non-artists than for artists – or else, the mental illness in scientists was less obvious or less likely to be reported. Social scientists showed rates of depression in the mid-20% range, and physical scientists showed rates in the low teens. Other groups showing lower rates of psychopathology included businesspersons, explorers, athletes, military figures, and social activists.

More subtle bipolar disorders and family history were not assessed. Still, where overt mood disorders are concerned, the best predictor is not being an eminent creative person but, rather, an eminent creative artist. Note, however, that there are many mood-disordered people who do not become eminent, or even highly creative. What other factors might combine to make the achievement of eminence in Western culture more likely? An experiment by DePetrillo and Winner (2005) found that doing creative artwork elevated self-reported mood in college students in whom low mood had been induced by exposure to videos showing distressing scenes. By contrast, simply copying abstract designs or solving challenging verbal puzzles did not elevate mood significantly. The mood-elevating effects of creative artmaking may make artistic endeavors especially attractive to individuals with mood disorders; this may help explain the over-representation of individuals with mood disorders among creative artists.

Kyaga et al. (2011) conducted a study in Sweden of over 300,000 people, using anonymized data from national hospital records and census data for an entire national sample of all patients with bipolar disorder, their biological relatives, and controls without a personal or family history of mental disorder. The authors compared the rates of artistic and scientific occupations – considered to be more creative – reported on census records, in the patients, their relatives, and controls. Individuals diagnosed with bipolar disorder were significantly overrepresented in creative occupations, an effect largely due to higher rates of visual (e.g., photographers and designers) and non-visual artistic occupations (e.g., authors and composers). The close relatives of the bipolar patients also reported elevated levels of creative occupations, but in contrast to the patients, the increase was greater for scientific than artistic occupations (Scientists were considered to be people who did research or taught at a university level). It is noteworthy that the researchers found, for both bipolar disorder and schizophrenia, that rates of creative occupations were greatest for the healthy first-degree relatives of patients, rather than the patients themselves.

Eminence Revisited: A Complex Equation

Robert Albert (1996) identified a finite number of early personal and family factors that may together yield a 'multiplier effect' on eminent achievement. These include parental and sibling characteristics, and family birth order. Many positive forces combine to provide personal strength, support, opportunity, and expertise. Albert also found that long-standing family interests or capacities were frequently made available to the individual, allowing a channeling of interests and a long-term immersion in a subject, with support of family and culture.

Strong motivation is important for creativity, especially for the creator with a bipolar disorder. Ruth Richards and Dennis Kinney have shown a definite preference for work-related over leisure-related creativity among bipolar subjects in a sample of everyday

creators. (By contrast, other research by Kinney et al. (2001) found that individuals with schizotypal personality traits, which are elevated in the relatives of schizophrenia patients, showed greater preference for leisure-related creativity.) A number of personality factors linked with bipolar mood disorders have been proposed that may raise the chance of eminent recognition when creative talent is already present. These factors include a driven work orientation, an ability to think in broad and ambitious terms, altruistic and socially concerned motives that may accompany mood elevation, a sense of 'standing apart' from the main-stream, and a need for external validation.

Results were similar for both artistic and non-artistic fields. Personal characteristics associated with creativity have included contrariness, capacity for solitude, physical illness or disability, drive for supremacy, production of work with a personal seal or signature, and a psychological 'unease' or drive. Mental disturbance is included in the 'unease.' Research on eminent individuals has found that psychopathology was four times as common in the most eminent as in the less eminent individuals.

Everyday Creativity and Mood Disorders: Considerations

Subjects Chosen Using Clinical Versus Creative Criteria

Let us now turn things around and start with subjects who are chosen because of their psychopathology, rather than their creativity. If all creative writers had mood disorders, one would not expect everyone with a mood disorder to be a creative writer. One still does hear, however, people making these associations of mood disorders with creativity as if the association were (a) always true and (b) reversible. It is not so. These associations are not predictive, probabilistic, and directional. Creative writers, or indeed people in any field who have achieved a measure of success, bring together a constellation of intellectual and personal qualities and strengths. This constellation might not be the case for the average person on the street, or for someone with a severe mood disorder. When we focus on eminent creators, we are not at the less-productive extremes of bipolar liability in the inverted-U relationship between symptomatology and creativity, but rather are somewhere into the more functional middle (raised) segment of the inverted-U curve.

Compensatory Advantage? A Key Study and Method

The phenomenon of compensatory advantage may be relevant to creative ability. In sickle cell anemia, inheritance of the same recessive mutant gene from both parents leads to serious and often fatal medical disease. By contrast, inheritance of only one copy of the mutant gene (i.e., carrier state) may often result in only a mild anemia, while providing a compensatory advantage of resistance to malaria. In the case of some psychiatric illnesses such as bipolar disorder, while the genetic model may be more complex, it seems plausible that certain genes that increase risk for the disorder may also carry a compensatory advantage involving increased creative potential. The numbers of people affected is important; millions of people are affected by mood disorders, so that the benefit of increased creativity would affect not just the achievements of a handful of highly eminent people, but the everyday lives of millions of individuals. This phenomenon may also involve a more complex variant of genetically based selection, favoring people who may contribute to memetic (or informational) evolution, as well as genetic evolution. Creative individuals facilitate growth in the units of information (or memes) that reflect creativity in the world, and these may subsequently affect genetic survival, as in the discovery of fire or of penicillin.

Accordingly, an inverted-U association has been hypothesized between creativity and degree of bipolar symptomatology. Richards, Kinney, and colleagues compared the creativity of individuals with bipolar disorder, patients with cyclothymia, and their psychiatrically normal relatives to each other, as well as to psychiatrically normal control subjects, and to individuals with another type of psychiatric diagnosis. The creativity variable involved a measure of the highest or peak level of real-life broad-based everyday creativity manifested in vocational and avocational activities, rated using the *Lifetime Creativity Scales*, consistent with evidence of a disposition toward originality. The mean rating for everyday peak creativity was higher among the clinical sample (comprised of bipolar and cyclothymic patients and the normal relatives) than controls, with the cyclothymic group showing higher creativity than the bipolar group. However, another group was also highly creative: the psychiatrically normal relatives of bipolar patients. See Kinney and Richards (2014) for a review of this research.

This is an important finding, indicating that the severe pain and suffering associated with full-blown mood disorders were not necessary for the hypothesized creative advantage. Nor did psychiatric normalcy explain the high level of creativity in the healthy relatives of bipolar patients, since the normal control subjects were not so distinguished. Interestingly, other researchers have also found advantages on achievement in general in relatives of bipolar individuals. These findings may support the inverted-U effect, if a subclinical hypomania or other mild affect is what produced the elevated creativity in the healthy relatives of bipolar patients. These results are also consistent with other research findings: (a) that increased creativity is linked to intermediate, rather than high or low, levels of Eysenck's psychoticism variable; (b) of subtle findings of thought eccentricity found in the normal relatives of bipolar patients; and (c) of higher mean scores on a clinical hypomania scale in creative college students, in the work of Schuldberg and others.

Notably, studies of over-inclusive thinking compared bipolar patients and eminent creators in their styles of thinking. Beginning with Andreasen's work in the 1970s, similarities have been found between writers and bipolar patients in particular, though with some key differences. Patients were less likely than the writers to make adaptive use of over-inclusive thoughts. Related research

found that eminent creators, despite having high mean scores on many Minnesota Multiphasic Personality Inventory psychopathology scales, also showed high scores for ego strength.

Conceivably, with treatment, certain mood-disordered people may show not just decreased symptomatology but increased creative productivity. This research underscores the potential value of eccentricity, and the importance of not pre-maturely judging creative people as ill. Unconventional thinking styles do not necessarily mean pathology – indeed, sometimes may be exceptionally valuable.

State Effects: Is a Good Mood a Good Thing?

When asked directly, non-eminent bipolar patients reported greater creativity during mild mood elevations than during episodes of mania or depression. Their creative periods were associated with characteristics of spontaneous exuberance and cognitive facility, including rapid thinking and fluent associations. Eminent artists and scientists gave similar reports, as the great majority had also experienced intense creative periods associated with many characteristics of mild hypomania.

The prominence in a sample of eminent writers of bipolar II disorder, rather than bipolar I disorder, with its more extreme mood elevations, is also notable. Mechanisms for these cognitive, affective, and motivational advantages of hypomania have been proposed. Other studies have found that even in the general, rather than the psychiatric, population, mild mood elevation – say, from watching a comedy film – can directly enhance creative problem solving. Mood elevation may also enhance cognitive style factors that can be relevant to creativity, such as unusual associations and the creative style factor of overinclusion. For example, in classifying things as flat, the over-inclusive person might mentally stretch a little further, and pull in more imaginative possibilities (or some might say loose, or inappropriate ones).

State Effects: What About Negative Mood?

Unipolar patients have reported a heightened sensitivity when depressed. They do not, however, necessarily report advantages ascribed by bipolar subjects to elevated mood states. Despite preliminary evidence that people with a history of depression may show higher everyday creativity if they have a family history of bipolar disorders, one cannot necessarily conclude that it is the episodes of the depression themselves that are conducive to creativity. Rather, it may be associated with sub-clinical hypomanic highs related to a family history of bipolar disorder.

State and Trait Effects: What About the Normal Relatives of Bipolar Patients?

Of great importance, for manic, schizoaffective, and schizophrenic patients, related (though very much muted) forms of thought disorder were found to be more common in their respective first-degree relatives, even those relatives who were not themselves clinically ill. This is consistent with the finding of elevated creativity in, for instance, the normal relatives of bipolar patients, and in depressed individuals with a bipolar family history, and it suggests operation of some subtle cognitive factors associated with the liability for bipolar disorder. In fact, there are particular qualitative patterns of unusual thinking that differentiate patients with mania from those with schizophrenia – as well as tending to distinguish their respective healthier relatives – patterns that might yield higher creative potential in bipolar patients and their relatives. For bipolar disorders, this involves combinatory thinking, with incongruous combinations of ideas and playful confabulation, as described in Philip Holzman and Mary Hollis Johnston's Thought Disorder Index. These patterns involve loosely tied together ideas and often have a playful quality to their production. These styles produce novel combinations of ideas and unconventional perspectives that may – with proper vetting – be valuable in generating innovative solutions to problems that would not occur to other people. For a review and recent research, see Morgan et al. (2017).

Evolutionary Significance

In October 1996, an invitational conference in New York, on *Manic-Depressive Illness: Evolutionary and Ethical Issues*, was convened by Kay Jamison of Johns Hopkins and Robert Cook-Deegan of the National Academy of Sciences. Participants came from around the world to discuss the genetic and environmental factors, social costs, and adaptive value of bipolar disorder. The participants, who included distinguished scientists and clinicians, urged caution, in this burgeoning era of genetic engineering, against any precipitous efforts to remove from the population gene(s) that increase liability for bipolar disorder, given that this liability is complex, not fully understood, and may have creative advantages for individuals and society.

Multiple authors have noted that a link of bipolar risk with creativity (and perhaps also with leadership) could help explain why genes that contribute to bipolar disorders have not been selected against, given the increased rates of mortality and morbidity in these disorders. A compensatory reproductive advantage would presumably help keep bipolar disorders (and genes that help cause them) around. A handful of eminent people, however dramatic their reproductive power, could not maintain bipolar spectrum disorders at a rate as high as 4%–5% of the population. Everyday creativity could be key in this regard. The liability for bipolar disorders must play out in everyday life in order to maintain an adaptive value and reproductive advantage great enough to compensate for the higher mortality associated with bipolar disorder.

Conclusions, Recommendations, and Optimistic Implications of Research

Links Between Creativity and Genetic Liability for Bipolar Disorder

In conclusion, several different lines of careful research have found evidence for a marked association between increased creative potential and genetic liability for bipolar disorder. Some studies have found evidence for elevated rates of artistic creativity in individuals with bipolar disorders, but the research also has found the greatest elevation of creative professions in the bipolar patient's close biological relatives – especially relatives who themselves are healthy and have no mental disorders! In addition, for those eminent artistic creators who do have a full-blown mood disorder, they report that their periods of greatest creativity coincide with episodes of mild mood elevation, rather than with episodes of mania or depression.

Multiple convergent lines of evidence indicate that the association of creativity with bipolar disorder is usually not due to a positive effect of periods of mania and depression; indeed, those periods may tend to be counterproductive for creative work. Rather, research suggests that the creative advantage for some people with mood disorders may lie in the episodes of milder mood elevation. Why might this be so?

Complementary research suggests that several psychological factors associated with milder mood elevation tend to be associated with interest in, and generation, of creative ideas, as well as with work to develop and win acceptance for creative works and ideas. Thus in scientific as well as artistic fields, creative breakthroughs often involve seeing problems in novel ways that have not occurred to others, and that challenge conventional wisdom in the field. Paradoxically, the greatest breakthroughs often prompt criticism, even ostracism, from authorities committed to traditional theories and genre. Picasso's fellow artists initially ridiculed his breakthrough art. Barry Wallace's Nobel-Prize-winning discovery that a bacterium caused stomach ulcers was ridiculed at first. JK Rowling's first Harry Potter novel was rejected by the first several dozen publishers.

Milder mood elevation tends to facilitate not only access to unusual ideas, but also increased energy, ambition, self-confidence, perseverance, and sociability. Those traits are key assets in overcoming resistance to new ideas, persisting despite initial rejections, and selling one's ideas to skeptical "gatekeepers" e.g., editors, patent officers, and gallery owners who decide whether creative ideas are recognized or die with their creators.

Some Optimistic Social and Clinical Implications

The research we have reviewed has several rather optimistic implications. First, the suffering and disability of severe moods are not a "price" one must pay for creative achievements. Second, the finding that milder mood elevation, rather than full-blown mania, is conducive to greater creativity may encourage bipolar patients to take mood-stabilizing medications (Patients' failure to take medication is a major factor in high rates of relapse and hospitalization). Third, links between enhanced creativity and bipolar liability may help reduce stigma and boost morale among patients and their relatives. Fourth, the link may lead families, teachers, counselors, and clinicians to encourage bipolar patients and their relatives to investigate creative jobs and hobbies – to the potential benefit of themselves and the broader society who reap the rewards of creative breakthroughs.

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- <http://www.saybrook.edu/> – Support site for a graduate program on creativity.
- <https://www.bbrfoundation.org/> – Support site for information about bipolar disorder.

Birth Order

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Introduction

Most children grow up with siblings. Do early experiences with siblings promote or discourage creativity? The collective wisdom about siblings is that they do influence each other in many ways, including the development of creative abilities.

Defining Sibling Categories

Birth order and the number of siblings in each family are the most commonly used sibling categories in research and theory. Children who are born first into their families are only children until their first sibling is born and then they become firstborns. Over time, more children may be born until the sibling set is complete and the last child is identified. In research, children whose order-of-birth puts them between the first and last born are grouped together and called middle borns. The number of siblings in the family, referred to here as sibship size, also influences the effects of birth order, not only by determining the number of middle borns in a family, but also by limiting the amount of parental investment available for individual children (Hertwig et al., 2002). In most research and theory, sibling effects have been portrayed as fixed, even though many sibling effects, including those associated with birth order and sibship size, are dynamic during the early years of childhood.

There are other sibling factors that can moderate the effects of birth order and sibship size on outcomes. One moderator is the age difference between siblings. For example, twins have no age gap. They interact almost continuously during childhood and their early experiences together undoubtedly influence their outcomes. In contrast, some siblings are much younger or older than their siblings, providing them with few opportunities for sibling experiences during childhood. Because of variations in age gaps between siblings, sibling effects for twins are likely to be much greater than sibling effects for those with larger age gaps.

Another type of sibling moderator involves gender and the gender composition of the sibling set. This moderator has been found to influence the development of each child's gender identity as well as his or her gender attitudes. Growing up with an opposite gender sibling provides children the opportunity to understand more about the other gender; while growing up solely with siblings of the same gender may intensify gendered attributes. Both age gaps and gender composition are involved in the development of creativity, as described below.

Birth Order, Age Gaps, and Gender Composition

Within the larger body of birth order research and theory, there is a relatively small group of studies about sibling effects on creativity. Much of this literature addresses the issue of whether firstborns are more or less creative than others. Overall, empirical tests aimed at discovering whether firstborns are more or less creative have reported mixed results. Some studies have found that firstborns have lower levels of creativity; while other studies have found that firstborns have higher levels of creativity than others. Still other studies have reported that firstborns are neither more or less creative than the other sibling categories.

Fortunately, one study (Baer et al., 2005) has addressed these inconsistent findings by examining if sibling moderators, such as age gaps, sibship size, and gender composition, can explain the mixed findings about firstborns. Baer et al. wondered whether firstborns with larger age gaps between themselves and their siblings would score lower in creativity than firstborns closer in age to their siblings. The rationale for this possibility was that firstborns with long age gaps would be more likely to be given the duty of caring for younger siblings (Rosenberg, 1982). Such caregiving experiences are thought to facilitate the firstborns' attainment of more adult-like qualities, such as responsibility, but these experiences are thought to inhibit the development of creativity. Conversely,

Baer et al. argued that firstborns with shorter age gaps would be less likely to be given the duty of caring for younger siblings, thereby avoiding experiences that dampen the development of creativity and instead, allowing for more time to engage in childhood play, an experience associated with the development of creativity.

Furthermore, Baer et al. considered whether the number of younger siblings affected the age gap hypothesis. They argued that having more younger siblings would enhance the negative effect of caregiving for firstborns with large gaps, while having fewer younger siblings would enhance the positive effects of sibling play on creativity.

The Baer et al. study involved teams of college students solving real-world problems including human resources issues and new product development. Teams were asked to generate as many creative solutions as possible for each problem. Shortly after completing each set of tasks, participants individually completed a web-based survey in which they rated the creative contributions made by each of their teammates. Each individual's contributions to the problem-solving tasks were evaluated for creativity by his or her teammates in terms of novelty as well as usefulness. Each participant received a composite creativity score, based on the evaluations of their teammates, across two tasks.

With these data, Baer et al. found support for the idea that age gaps and sibship size moderated the creativity of firstborns. Specifically, they found that firstborns who were closer in age to their (smaller number of) siblings had higher creativity scores; while firstborns who were further in age from their (larger number of) siblings had lower creativity scores. This finding demonstrated the relation between age interval and creativity, which has been found in previous research (Gaynor and Runco, 1992).

Baer et al. also wondered about the effect of having more opposite-gender siblings on creativity. Several studies have concluded that more experience with opposite-gender siblings promotes psychological androgyny in children, and this combination of both masculine and feminine attributes is thought to enhance creativity (e.g., Wagner et al., 1993). The results of the Baer et al. analyses supported this expectation. That is, they found that firstborns with more opposite-gender siblings scored higher on creativity than firstborns with more same-gender siblings.

Overall, the Baer et al. findings suggest that firstborns are a heterogeneous group, especially in terms of understanding their level of creativity. Although all firstborns have younger siblings, the distance between the first and later borns, either in terms of age or gender, and the number of younger siblings they have, affect the experiences of firstborns as they mature. These experiences ultimately contribute to their developing varying degrees of creative abilities. Firstborns with short age gaps, fewer siblings, and opposite-gender siblings are advantaged in terms of developing creativity.

Growing Up Without Siblings

Children who are the first child of their parents, but never acquire siblings, are labeled only children. All firstborns are only children for a limited duration during childhood; however, only children are distinct in that they are simultaneously the first and last child within their families. This section will focus on emerging research suggesting that only children exhibit greater capacity for creativity.

Mechanism Promoting Creativity in Only Children

There are several mechanisms potentially contributing to this greater creativity among only children; three are described here. The first involves the fact that one-child parents can invest all their resources, including attention and affection, into supporting their single child's development (Hertwig et al., 2002). Parental investment is thought to promote the intellectual and socioemotional development of children generally, and the fact that only children get more parental investment than other children probably accounts for their greater intellectual abilities and self-esteem (Falbo and Polit, 1986). In turn, these positive developmental outcomes for only children facilitate their expression of creativity (Sternberg and O'Hara, 1999).

The second mechanism facilitating the development of creativity involves the likelihood that only children spend more time alone as they are growing up, giving them more opportunity to become comfortable with, and maybe even develop a preference for, lower degrees of sociability (Falbo and Polit, 1986). Recently, Bowker et al. (2017) found that one type of social withdrawal, which they called "unsociability," benefitted individuals, by enhancing their creativity. Therefore, the greater likelihood that only children spend time alone as children may afford them more opportunity to develop creativity, and if they retain their unsociability as adults, they may retain their advantages in creativity.

The third mechanism involves parents of only children being more likely to promote gender role flexibility, especially for only-child daughters. An early study (Katz and Boswell, 1984) found that parents of one child expressed greater comfort with gender nonconformity for their children than did parents of multiple children, perhaps because their single child must satisfy the parents' desire for both a son and a daughter. In turn, greater gender role nonconformity has been associated with the development of creativity (Baer et al.).

Although any one of these three mechanisms could promote the development of greater creativity in only children, the combination of all three mechanisms for only children probably amplifies these effects on the development of their creativity.

Chinese Only Children

In the past, studies of sibling effects on creativity have either removed only children from their sample, because only children have no siblings, or they have combined them with firstborns, due to the small numbers of only children in their samples. More recently,

however, one-child families have become more common, especially in China, and we now have more only children to study as a separate category in research. Two such studies about only children and creativity are highlighted here.

The first study of Chinese only children and creativity (Yang et al., 2017) was remarkable in that it combined MRI data with assessments of creativity using the Torrance Test of Creative Thinking (TTCT). The TTCT was designed as a measure of divergent thinking, a central aspect of creativity, and it included verbal, figural and auditory tests. The performance of participants was scored along three dimensions: fluency, flexibility and originality. Although scores for each dimension can be considered separately in research, these three scores can be combined to create a total score.

The Yang et al. findings indicated that only children scored higher on one of the three creativity dimensions, flexibility, reflecting greater capacity to shift between conceptual fields. There was no significant difference between only children and their peers with siblings on the other dimensions of creativity.

Furthermore, analyses of the MRI data indicated that parts of the brain associated with creativity had higher volume in only children than in their peers with siblings. Specifically, the MRI results indicated that there were gray matter volume differences between only children and their peers with siblings, in the brain region of the supramarginal gyrus. Greater volume in this region was found to be positively correlated with flexibility scores. Thus, the authors concluded that growing up without siblings in China led to these children having more experiences that promoted the development of the part of the brain associated with some dimensions of divergent thinking.

The second study about only children and creativity considered gender in combination with birth order (Guo et al., 2018). The participants were given two tests of divergent thinking: one involved imagining all the possible meanings of irregular figures and the other involved responses to real-world problems. Overall, the results indicated that only children scored higher on visual imagination (line meaning) tasks than children with siblings. Furthermore, the group with the highest combined creativity scores were only-child daughters.

Guo et al. explained these findings in terms of the effect of China's One-Child Policy (OCP) on the development of children, especially girls with no siblings. The propaganda surrounding the implementation of the OCP emphasized that limiting families to one child would produce high "quality" children who would become the vanguard of China's emergence as a world leader. Educational opportunities were expanded in China so that only children could obtain the advantages associated with greater educational attainment. Several studies have documented that Chinese only children on average scored higher on tests of intellectual ability than did their peers who grew up with siblings (Falbo and Rodgers, 2019).

China has had a long tradition favoring sons over daughters, with parents investing more in the education of their sons, because they expected sons to support their parents when the parents were no longer able to take care of themselves. Daughters were expected to marry into other families and serve the interests of their husband's family. The family planning policy challenged this tradition, forcing parents to accept the fact that they could have only one child, even if that child was a daughter. According to Fong (2004), parents of only daughters responded by pushing their daughters to become academically skilled and emotionally strong, so that they could grow into the role that sons had traditionally taken. Parents of only-child daughters did this by providing their daughters with all the enrichment they could afford, including advanced schooling, music lessons, and foreign language training. Furthermore, not only were these daughters trained to step into roles more commonly taken by men, but they were also expected to exhibit desirable feminine attributes. Thus, only-child daughters were given early experiences that promoted the development of their creative abilities, and therefore, it is not surprising that Guo et al. found that they excelled at creativity.

It is possible that this finding of greater creativity among only children, and only-child daughters in particular, may be limited to China, where the OCP promoted the one-child family as a national policy. While the Chinese policy probably amplified the power of mechanisms that promoted the creativity of Chinese only children, there have been research studies based on Western samples finding that only children were overrepresented among classical music composers (Schubert et al., 1977). Thus, it is possible that only children in general are more likely to acquire creative abilities, due to greater parental investment, spending more time alone as children, and the likelihood that their parents promote greater gender role flexibility in their children, especially in their daughters. More research is needed in order to determine if the advantages of only children, in terms of the development of their creative abilities, are more pronounced in China than other countries, and whether significant only-child effects on creativity can be found in samples from other nations.

Are Sibling Effects Permanent?

Are sibling effects on creativity permanent? Can the assumption be made that only children and firstborns will retain the levels of creativity they developed in childhood throughout their lives? Are middle or last borns destined to low levels of creativity? Based on theory and research about sibling effects in general, the answers to these questions are no, no, and no. The collective wisdom about sibling effects is that they are often found to be so small as to be not significant and when they are found to be statistically significant, they are typically small in size.

Furthermore sibling effects are more likely to be found when research participants are younger, as children, adolescents, and young adults. This is not surprising since siblings growing up in the same household are forced into a situation of sharing their family resources, including parental attention and affection. Consequently, children may develop behavioral tendencies and thinking skills in response to their shared household that result in the development of more or less creativity.

When siblings grow up and leave home, however, sibling effects may become weaker. For example, firstborns who played with their younger siblings, instead of supervising them, may develop high levels of creative abilities, as shown in early adulthood. But, if they are placed in adult roles that allow for little expression of creativity, over time, this new environment and its demands is likely to diminish their creativity. Conversely, middle borns may leave home and find themselves in work environments requiring them to spend more time alone, or alternately, in work environments that allow them substantial time playfully interacting with peers. These experiences may lead to an enhancement of their creative abilities. Because of these new experiences after leaving home, sibling effects on creativity may diminish as individuals mature in middle age and later life. The weakening of sibling effects across the lifespan explains why some researchers have reported finding no significant birth order effects, especially when long spans of longitudinal data are considered, or when other factors, such as socioeconomic status, are included in analyses.

Instead of permanent sibling effects on creativity, we argue that engagement in activities known to promote creativity, such as engagement in intellectual stimulation or spending time alone, promotes the expression of creativity, regardless of sibling status.

Future Directions

To our knowledge, empirical studies investigating the relationship between birth order and creativity have typically employed between-family research designs, which have examined these effects at one point in time (i.e., cross-sectionally) with all participants unrelated to each other. Such research designs usually fail to adequately control the confounding factors relevant to between-family differences, such as socioeconomic status, sibship size, neighborhood context, family dynamics and inherited traits. Such factors are relevant to the development of creative abilities in children and adolescents and yet, they are largely determined by historical and demographic factors outside of the control of researchers and their statistical analyses.

Due to the limitations of these between-family designs, future studies of sibling effects on creativity should consider employing longitudinal, within-family designs. These within-family designs would allow for the examination of sibling effects on creativity within the same family over time. One major advantage of within-family designs is that they may perform better in controlling confounding factors because participants are clustered together within family, limiting the influence of such factors as genetic inheritance. By using longitudinal and within-family research designs, changes in birth order and other sibling factors, as well as changes in creativity, can be observed and evaluated. This approach is likely to yield results that expand our understanding of siblings effects on the development of creativity.

Another approach to advancing our understanding of sibling effects on the development of creativity is to apply qualitative methods to the examination of sibling effects within families. The research results described in this entry were all been based on quantitative studies of sibling effects on creativity. However, another approach, based on smaller samples of families with in-depth qualitative data about each family member, may well provide the types of data and analysis that will advance knowledge of sibling effects on the development of creativity.

An example of a more qualitative approach can be found in *The Pecking Order* (Conley, 2004), a book that combined publicly available information about famous siblings, with the information provided by interviews of siblings from more typical families. As such, this book provides insights into the dynamics of sibling effects, over the course of childhood, adolescence, and adulthood. Conley combined information about genetic influences on individual differences between siblings, describing how these differences are perceived by siblings and parents. He also described the influence of growing up in large families, arguing that some of the strongest sibling effects can be found with larger numbers of siblings. He also addresses the effects of losing family members on sibling effects as well as the effects of gender composition and expectations on children's development. Unfortunately, Conley did not address the development of creativity. However, scholars can use Conley's approach in future books to advance knowledge of sibling effects on the development of creativity.

Other qualitative approaches to research in this area involves more granular data collection from single families, following siblings over time to determine how their experiences at home with each other affects the development of creative abilities. Interviews of siblings within families would be especially informative, particularly if the sample focuses on specific domains of creativity, such as music or media, and there are research questions focusing on perceived obstacles and stimulants to the siblings development of creativity.

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Breadth of Attention

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Glossary

Breadth of Attention the number and range of stimuli in the environment or concepts in the associative network attended to at any one time.

Convergent Thinking analytical, controlled, goal-oriented thinking using algorithms and directed towards finding a correct solution.

Divergent Thinking is based on the generation of multiple ideas or the reinterpretation of a problem; relies on the activation of concepts within an associative network.

Scope of conceptual attention defined as the range of activation of mental representations in long-term memory.

Type-1 processing fast, automatic, and nonconscious cognitive processing.

Type-2 processing slow, deliberate processing based in working memory.

Definition of Breadth of Attention

Breadth of attention refers to the number and range of stimuli in the environment or concepts in the associative network attended to at any one time. People exhibiting a narrow state of attention focus on a relatively small range of information and filter irrelevant data from their awareness. Conversely, people having a broad state of attention focus on a large range of stimuli or concepts and tend to be more aware of irrelevant information. The distinction between broad and narrow attention has also been framed in terms of global and local features, or said differently, seeing the forest (broad attention) or seeing trees (narrow attention).

In the field of visual attention research, Navon (1977) asserted that breadth of attention corresponds to the manner in which information is processed: broad, or global attention, corresponds to global-to-local, or top-down information processing, which under normal circumstances is how humans tend to process information. Gestalt psychologists posited that humans process information holistically, a view that gave rise to the global-precedence hypothesis that was widely supported in initial studies. However, later research disputed the inevitability of top-down processing arguing, that initially, information is briefly processed in a bottom-up manner, and that only then, do top-down processes assume control. Top-down processing also influences the size of attentional window, i.e., it can broaden, or narrow attention based on the demands of the environment. Similarly, perceptual processing research has shown a distinction between contextually and conceptually driven processing. Contextual processing is guided by sensory information, which corresponds to a narrowing of attention while engaged in task performance; whereas conceptually driven processing is guided by concepts stored in long-term memory, which corresponds to a broad attentional focus.

Attention and Creativity

Attention is linked to creativity in several ways. Anecdotal accounts from eminent creators reveal that during the creative process many inventive individuals have a difficult time screening out irrelevant stimuli, such as incidental sounds, thereby suggesting that they experience wide attentional breadth while creating. Creative scientists also reported changes in their attentional focus during the creative process. With regards to insight, they described their attention as “diffused” just prior to an insight, and as “scanning” once an insight was achieved. There is also controlled research related to the influence of attention on creative thinking.

Theoretical Considerations

Mednick's influential Associative Theory of Creativity (1962), proposed that a greater amount of creative ideas are achieved through accessing more distant nodes in the associative network. The theory suggests a relationship between the scope of attention and creativity. That is, broader attentional scope should facilitate access to more peripherally located original information, resulting in the higher probability of coming up with more unorthodox creative responses. Mednick proposed that individual differences in the strength distribution of associative responses are responsible for individuals' differences in creativity.

Mednick distinguished between individuals with steep and flat associative hierarchies. Individuals with steep associative hierarchy tend to be restricted to stereotypical responses, i.e., responses high in associative strength. The associative strength of responses to stimuli for individuals with a flat associative hierarchy is more equally distributed, thus increasing their probability of producing a more remotely associated, and therefore less stereotypical, response. Mednick asserted that, "It is among these more remote responses that the requisite elements and mediating terms for a creative solution will be lurking" (Mednick, 1962, p. 223). Contingent on this, individual differences in response associative strength can be viewed as differences in breadth of conceptual attention, i.e., individuals with a steep associative hierarchy can be described as having a narrow scope of attention, and individuals with a flat associative hierarchy can be viewed as having a broad scope of attention (Martindale, 1995). Thus, individuals with a broad attentional scope will tend to produce the least stereotypical, and therefore, most creative, responses. (See Remote Associates)

Mendelsohn (1976) similarly thought that a wide breadth of attention facilitates creative performance. He noted that "the greater the attention capacity, the more likely the combinatorial leap which is generally described as the hallmark of creativity" (p. 366). Mendelsohn viewed attention as an important variable in studying creativity that is independent from intelligence.

In a series of studies, Mendelsohn and his colleagues showed that a wide breadth of attention aided creative performance.

Divergent and Convergent Thinking

Guilford (1956) created a differentiation between what he called divergent and convergent thinking. Divergent thinking usually occurs in an ill-defined problem space, where no specific description of a problem situation is given, and the criteria for an outcome is incomplete or lacking. It is generally characterized by the generation of multiple ideas to a given situation or the reinterpretation of an initial problem. Additionally, there is the presence of a heavy reliance on heuristics and the accessing of remote associates in the associative network. Guilford viewed divergent thinking as a synonym of creative thinking, and as the opposite of convergent thinking. (See Divergent Thinking) He described convergent thinking as a non-creative thinking process geared towards giving the "correct" answer to a well-defined problem. Later, convergent thinking descriptors were expanded to include terms such as analytical and logical thinking and further as controlled processing and the application of algorithms.

Numerous studies found that greater attentional breadth causes increase in divergent thinking scores. Attentional breadth was examined as both a dispositional characteristic and a situationally induced state.

Kasof (1997) found that dispositional breadth of attention was modestly and positively correlated with the creative performance of writing poetry. And further, that creative performance was affected by noise; in particular, noise impaired the creative performance of participants having a wide base-line attentional breadth more so than with those having a narrow breadth of attention.

Kasof proposed a *complexity hypothesis* to explain these findings. Creative tasks are more complex than other intellectual tasks (such as comprehension or memorization), thus they require greater parallel processing (vs. serial processing), and consequently, greater attentional breadth. On the other hand, simpler tasks do not benefit from greater attentional breadth, as these require a narrower attentional focus to only task-relevant cues. Based on this hypothesis, the more complex the creative task, the more beneficial wide attentional breadth.

Indeed, studies found that situationally induced broad attention was related to better performance on divergent thinking tasks. Participants in the broad attention condition showed greater originality than those in the narrow attention condition. Interestingly, in one experiment, simply manipulating the muscular groups associated with broad or narrow attentional focus affected creativity in a similar manner.

Longitudinal research looked at how attentional training programs may change sports creative performance over time. After completion of a six-month training program, creativity was measured using tactical games that incorporated real-life sports scenarios. These narrow and broad attentional programs improved various aspects of creative sports performance: broad attentional programs improved complex task performance, whereas narrow attentional programs improved simple task performance.

Other studies looked more specifically at the relationship between the scope of conceptual attention and creativity. Broader conceptual attention was associated with higher levels of creativity than narrower conceptual attention. Moreover, broader conceptual attention has not been associated with analytic thinking. Yet, the support for the relationship between broader attentional scope and creativity has not been uniform, with some studies detecting only weak or no relationship, suggesting that if a relationship exists, it is likely small.

Some study findings indicated that creativity might be associated with an impaired functioning of the filter of attention. Necka (1999) found that longer reaction time on attention tasks requiring response inhibition was associated with higher divergent thinking scores, particularly when task complexity increased. Thus, participants who scored higher on the creativity measure had poorer attentional functioning indices, i.e., had a weaker filter of attention than less creative participants.

Nęcka attributed the confusing results of selective attention impairment in creative individuals to a susceptibility to “irrelevant” stimuli that are normally ignored or suppressed. These unusual connections may lead to a greater creativity of responses. In terms of broad/narrow attention, filter of attention, that which provides an ability to filter information, implies a narrowing of attention. Thus, participants who exhibited broader attention had better divergent thinking scores, yet, their ability to filter out irrelevant stimuli was reduced.

Conversely, other studies showed a reversed causal relationship between creativity and attentional breadth. That is, they indicated that engaging in divergent tasks, but not analytic reasoning, broadens the scope of attention (Wronska et al., 2018). With this line of reasoning, attentional breadth is adjusted based on the requirements of a task. Specifically, it broadens when working on tasks requiring access to distant associates in the semantic network, such as divergent thinking tasks, and narrows when working on more data driven tasks that require a singular correct solution, such as analytic problems. Similarly, another study found that broad attention facilitated performance in traditional divergent thinking tasks (e.g., an alternative uses task), but that narrow attention aided performance on tasks requiring extrapolation to a novel situation (Tidikis et al., 2017).

Dual-Process Models of Creative Thinking

Later research questioned Guilford’s idea that only divergent idea production begets creative thinking, while convergent thinking has no association with creativity. Recent studies show divergent thinking as a necessary, but insufficient step in the creative thinking. To produce something original and useful, one must not only come up with a novel idea, but also develop that idea into a realized solution. This other, necessary phase of creation is data driven, analytical, and relies chiefly on processes occurring in the working memory.

The binary nature of the creative process has been conceptualized in different terms. For example, most insight problem researchers delineate at least two distinct stages in achieving an insight: the first stage is generative, associated with a search through the mental representation space, and the second is associated with finding a solution based on a formed representation. Similarly, the Genevieve model differentiates between the generative phase, and the exploration and interpretation phase, with the former relating to divergent, and the latter to convergent thinking. The first step in the creative process, during which incubation and preparation occurs, is associated with defocused, broad attention. This stage is characterized by divergent thinking, conceptually driven processing, a search for novel and unorthodox ideas, and new ways of problem representation. The second step in the creative process is characterized by focused, narrow attention and is associated with illumination and verification. This stage is characterized by data driven information processing and convergent thinking.

These two stages work in opposition to one another progressing through multiple iterations during the creative process. Broadening of attention is associated with an exploration stage. When fresh ideas are brought into awareness, attentional focus is broadened to encompass new possibilities, remote, and seemingly unrelated ideas; in short, most research has traditionally linked this stage to divergent thinking and creativity. During the latter, or convergent thinking, stage, which is associated with a narrowing of attention, new ideas that were brought to attention during the previous, or divergent thinking stage, are scrutinized and strictly analyzed. Unworthy ideas are discarded, while worthy ideas are retained. If no solution is found, the process repeats itself until a satisfactory solution is achieved or the individual gives up.

It is worth noting, that these two stages vary dramatically in terms of their correlates, with many correlates having a positive relationship within one stage, while having a negative relationship within the other stage. For example, the first stage is associated with a higher number of ideas produced, while the second stage is associated with a better quality of ideas, originality, and a restructuring of mental representations. Likewise, analytical data scrutinization and data-driven processing are crucial second stage activities, whereas, these activities would be detrimental during first stage processing, when the production of unusual and unorthodox ideas is important.

Another prominent model of creative problem solving (Nijstad et al., 2010) delineates between two opposing cognitive processes involved in the creative thinking. Known as the dual-pathway model, it differentiates between two distinct means of achieving a creative solution: flexible and persistent thinking. Flexible thinking, traditionally linked to divergent thinking, works towards a creative solution through a combination of distantly related ideas, and the easy switching among those ideas. Consequently, broad attentional focus should benefit this flexibility. On the other hand, persistent thinking refers to the focused and structured search of a limited number of ideas. Attentional breadth should not affect persistent pathways. Studies have, indeed, found empirical support for broad attention favorably affecting flexible, but not persistent thinking. Flexibility and persistence were also found to be negatively correlated.

Studies found that processes associated with what traditionally been named divergent thinking relying on System 1 automatic processes, flexible thinking, and activation of the distant nodes in the associative network benefit from broad attentional focus. On the other hand, processes that rely on System 2, persistent thinking, and working memory benefit from the narrow attention breadth (Tidikis et al., 2017). Thus, the relationship between attentional breadth and creativity depends on the types of cognitive processes a person is utilizing.

Thus, different relationship between attentional breadth and creativity may be observed depending on a task a solver is performing.

Variables Related to the Breadth of Attention

Cognitive Factors

How is the attentional breadth related to closely related constructs [such as working memory (WM), or attentional control]? Studies found that wider attentional breadth was related to a greater WM capacity. Such relationship might be driven by the flexible allocation of attention or attentional control that allows for more diverse selection of stimuli. While having a great deal of shared variance with WM, attentional breadth does not relate to the inhibitory control function of WM.

Research also differentiates between two different aspects of attentional breadth—orienting sensitivity and effortful control and, examined their relationship with two differing creativity types—divergent thinking and insight problem-solving. It appeared that differing aspects of attentional breadth relate differently to two types of creative tasks. More specifically, higher scores on orienting sensitivity predicted greater insight problem solving success, but orienting sensitivity's relationship with divergent thinking was much weaker and disappeared altogether after openness to experience and intelligence were controlled for. Effortful control, on the other hand, predicted higher divergent thinking scores, but not insight problem solving performance.

Emotions

Creativity research has devoted a considerable amount of attention towards emotions as a factor having significant influence on the creative process. [Amabile \(1983\)](#) proposed that emotions may influence creativity through two pathways: motivational and cognitive. One way in which emotion may influence cognitive processes is through broadening or narrowing of attentional focus.

Early investigative work into the relationship between emotion and attention established that high negative emotional arousal causes a narrowing of attention. [Gasper and Clore \(2002\)](#) investigated the effects of emotions on global-local information processing. The results showed that participants in a negative mood condition were less likely than those in a positive mood condition to match a figure based on its global features. Similar findings were obtained in a [Fredrickson \(2000\)](#). Fredrickson reasoned that from an evolutionary perspective, positive moods elicit broad attention that facilitates exploration and experimentation. While negative emotions and narrow attention facilitate survival and problem solving, positive emotions and broadened attention promote play and exploration, facilitating an individual's growth.

However, some studies found anxiety to be related to attentional breadth in a curvilinear fashion, with those participants exhibiting the highest and lowest levels of anxiety showing broader attention than those in less extreme conditions, showing that arousal may play an important role in the emotions/attentional breadth relationship. Similarly, [Gable and Harmon-Jones \(2008, 2010\)](#) took arousal into consideration when looking at the effects of emotion on breadth of attention. In their 2008 study, they found evidence that positive affect high in approach motivation reduced breadth of attention. The authors argued that the reason previous studies found otherwise (that positive mood broadens attentional focus) is due to the fact that these studies manipulated positive affect low in approach motivation. Like the results of previous studies, positive mood low in approach motivation increased global attentional focus. The authors explained these results in terms of evolutionary perspective. Positive affect low in approach motivation implies stability and comfort, which fosters a broadening of attention for play and exploration. Conversely, positive affect high in approach motivation implies desired goal pursuit, in which case, the narrowing of attention serves the function of shutting off irrelevant stimuli that might distract from achieving the main goal.

In a 2010 study, Gable and Harmon-Jones found that while negative affect high in motivational intensity narrowed attentional focus, negative affect low in motivational intensity broadened attentional span. They suggested the reason previous research found that negative affect narrows the scope of attention is due to the fact that only negative affect high in motivational intensity was investigated. Different from most other research, the authors used participants' response time, rather than the number of global-local selections as a dependent measure. The results showed that reaction time between global and local targets was larger in the negative (sad) mood condition than in the neutral mood condition. Additionally, participants in the sad mood condition showed a slower response time to local targets, while reaction time to global targets was similar across all conditions. This was taken as evidence of sad photographs causing a broadening of attention. In a follow-on experiment, the effects of high-motivation negative affect (disgust) were examined. Participants in the disgust condition responded faster to local targets than to global targets, thus showing a narrowing of attention. These results suggest that deactivating negative mood states high in avoidance (sadness), broaden attention, while activating negative moods high in avoidance (disgust), narrow attention.

Other research using a dimensional approach (as opposed to discrete) to emotions found an opposing trend of the relationship between negative emotion high and low on arousal, and breadth of attention. Highly arousing negative emotion caused broadening of attentional focus, while negative emotion low on arousal led to narrowing of attentional breadth ([Tidikis et al., 2017](#)).

Personality Variables

Studies investigating affect associated with personality characteristics also found a similar relationship between mood and attention. For example, introversion, a trait usually associated with narrow attentional focus was found to correlate with attention to negative cues, while extraversion, a trait associated with habitually broad attentional focus, was found to correlate with attention to positive cues ([Derryberry and Reed, 1994](#)).

Conclusion

Research indicates support for the relationship between the broad scope of attention and higher creativity scores, particularly when creativity is measured as the number of divergent ideas produced or the originality of ideas. However, to fully appreciate the relationship between attentional breadth and creativity it is useful to consider the differing cognitive processes involved in creative cognition. Greater breadth of attention correlated with higher scores on tasks requiring accessing remote associates in the semantic network, such as divergent thinking tasks. Such relationships appear to be low to moderate. Narrower attentional breadth has been related to better performance on tasks requiring more effortful, analytic, and data driven processing. Other variables may also mediate the relationship between attentional breadth and creativity. The variables that received the most research are cognitive processes, emotions, and arousal.

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Childhood Trauma: Shadow of Darkness

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Childhood trauma encompasses abuse, neglect, and exposure to violence. A more global term, childhood maltreatment, is often employed to capture a range of negative events that threaten optimal development (D'Arcy and Meng, 2015; Felitti and Anda, 2010). Exposure to maltreatment or adversity may lead to injury and/or damage to multiple systems (neurological, physical, psychological, emotional), and in extreme cases, death. Child maltreatment frequently occurs within the family setting; however, children are also at increased risk for victimization in the community (bullying, assault, robbery, kidnapping, trafficking), and within institutions (i.e., church, military, gangs). Behind closed doors, children are vulnerable to abuse inside and outside the family system. For example, teachers, coaches, and medical care workers all have access to children; the unequal power differential may lead to manipulation, coercion, and abuse of minors who are in their charge (Thomson and Jaque, 2019).

The ACE Study

The Adverse Childhood Experience (ACE) study first began in Kaiser Permanente's Department of Preventive Medicine in San Diego. Dr. Vincent Felitti joined forces with the US Centers for Disease Control and Prevention (CDC) under the leadership of Robert Anda. In 1998, the early ACE study results demonstrated strong associations between adult medical problems and childhood adversity (Felitti et al., 1998). In this early study, individuals with four or more types of childhood adversity had a four to twelve-fold increase in health risks for alcoholism, drug abuse, depression, smoking, sexually transmitted diseases, ischemic heart disease, cancer, chronic lung diseases, skeletal fractures, liver disease, and suicide (Felitti et al., 1998; Felitti and Anda, 2010). The overarching findings indicate a dose response relationship between ACEs and health-related disorders.

Findings from ACE studies indicated that the same child may experience multiple forms of abuse and neglect; this intensifies the complexity of their stress responses (psychological, physiologic, and behavioral). For example, many minors who are exposed to physical or sexual abuse typically experience emotional abuse as well. Domestic violence often increases the likelihood of parental separation or divorce. Children exposed to domestic violence also experience more physical and emotional neglect, higher rates of mentally ill or addicted family members, and incarcerated family members (Felitti and Anda, 2010). Exposure to violence also increases when children are raised in communities or nations that are dominated by events such as ethnic cleansing or war (politically or gang motivated). A factor that further increases morbidity and mortality rates is when children are polyvictimized by multiple perpetrators. All forms of victimization may last a short period of time or extend over years.

Prevalence Rates of Childhood Adversity

The prevalence rates for any form of childhood maltreatment vary between studies, in part due to under-reporting in many countries or communities. Studies indicate that the prevalence rate for any single type of maltreatment is 32% (Afifi et al., 2011). According to

the U.S. Department of Health and Human Services, children under the age of three years old are regarded as the highest group to be victimized with a steady decrease in incidents as the child ages. Approximately 10% of children each year suffer at least four or more types of maltreatment. Gender, ethnicity, disability, single parent families, and foster care children are all factors that influence increased prevalence rates, including higher polyvictimization.

In an epidemiology study (D'Arcy and Meng, 2015), exposure to any type of childhood maltreatment increased the odds ratio (OR) for adult depression (OR = 2.03) and anxiety (OR = 2.70). This epidemiology report suggested that more than half the global cases of depression and anxiety are associated with childhood maltreatment. This same odds ratio (1.4–7.9) pattern is evident for childhood maltreatment and other psychiatric disorders such as bipolar disorder, alcohol and drug abuse, attention deficit disorder, suicidality, personality disorders, dissociation, somatization, and PTSD (Afifi et al., 2011; D'Arcy and Meng, 2015). Worldwide, there is a strong association between childhood adversity and multiple disorders throughout all life-stages (Kessler et al., 2010).

Attachment Formations and Developmental Vulnerabilities

Ultimately, all forms of childhood maltreatment interfere with the formation of secure caregiver attachment systems. Exposure to substantial childhood adversity is significantly related to sustained difficulties resolving past trauma and loss experiences as well as increasing the prevalence of insecure and disorganized attachment patterns (Thomson and Jaque, 2019). Parents with a history of high ACEs are more likely to have children with greater behavioral problems. These parents are inadvertently transmitting dysregulated behavioral responses to their children, including higher incidence of attention-deficit/hyperactivity disorder and diagnoses of emotional disturbances (Felitti and Anda, 2010). In addition, parents who are warm and structured promote creativity in their offspring, whereas parents who are coercive and chaotic harm creativity and a sense of autonomy in their children (Moltafet et al., 2018). These attachment-related experiences become internalized and influence behavioral activating or deactivating coping strategies under stressful situations. These internal attachment models deeply influence exploratory and creative behaviors, with secure attachment models promoting exploration and insecure or disorganized attachment models compromising or stifling exploration.

During development, maltreated children and adolescents exhibit difficulties managing academic and social demands; they struggle with emotional and behavioral regulation (Cook et al., 2005). Trauma exposure compromises their academic achievement and constrains cognitive flexibility and creativity during problem solving tasks. Deficits in executive functioning, attention, and abstract reasoning are evidenced. They frequently suffer a myriad of physical illnesses and they are at high risk for re-victimization throughout childhood and adulthood (Turner et al., 2010). Increased exposure rates are directly related to stress-related disorders such as PTSD, depression, personality disorders, as well as behavioral difficulties (Connell et al., 2018). During adolescence, maltreatment history is associated with increased negative behaviors such as non-suicidal deliberate self-harm, maladaptive belief schemas, and greater vulnerability when participating in events that may increase harm, shame, and self-sacrifice. These difficulties are even more pronounced when cumulative childhood adversity includes emotional neglect and emotional abuse. Collectively, these experiences often promote low self-esteem and poor self-concept (Cook et al., 2005).

Alterations in Neurophysiologic Stress Systems

Robust research demonstrates that exposure to childhood maltreatment alters neurobiological stress systems. Physiologic systems responsible for maintaining stability during environmental challenges are activated at a disproportionate rate in maltreated children compared to non-maltreated children (Danese and McEwen, 2012). Unlike homeostasis, allostasis is a physiologic response that detects external and internal challenges required to adapt to extreme demands (Danese and McEwen, 2012). When allostatic processes are continually engaged, structural and functional changes occur in stress-sensitive systems such as the autonomic nervous system, endocrine system, immune system, and neurological networks such as the executive, default mode, and salience networks (McEwen et al., 2012). These structural alterations are even more prevalent in individuals who are exposed to maltreatment in very early childhood. Alterations also occur at the genetic level with polymorphism changes associated with gene by environment interactions; gene methylation is directly associated with children suffering early life stress (Romens et al., 2015).

These neurological and physiologic changes persist and are clearly evident in adults with histories of childhood maltreatment. They have substantially more psychophysiological reactivity during any small or large traumatic reminder. These individuals struggle to manage stressful situations, including relational stressors. The rapid mobilization of the stress systems ultimately increases inflammatory processes, which increases rates of morbidity and mortality. Studies also identified increased pro-inflammatory conditions that result from cumulative trauma, especially childhood maltreatment (Baumeister et al., 2016). In a meta-analysis study, researchers determined that adult individuals who were exposed to childhood trauma had elevated baseline C-reactive protein, interleukin-6, and tumor necrosis factor- α , especially for those with histories of physical, sexual, or emotional abuse (Baumeister et al., 2016). In addition, a dose response to childhood adversity exposure negatively alters the executive cortical network, which compromises executive functioning. Consequently, children and adolescents struggle with emotional regulation, attention shifting, working memory, and organized thinking; these difficulties generally extend into adulthood. These executive functioning deficits are associated with greater PTSD symptom severity and externalizing behavior, a pattern that is even more extreme in polyvictimized individuals (Turner et al., 2010).

Deficits, Protective Factors, and Creativity

Childhood maltreatment is significantly related to difficulties in academic and social achievement, including realizing creative potential. For example, empirical evidence suggests that exposure to conditions of war trauma impedes creative development. Creative children tend to react more negatively to traumatic events; their ability to find creative expression is compromised and as a result, they may react with more hostile oppositional behavior (Knezevic and Ovensik, 2002). As well, very young children who are exposed to maltreatment are at higher risk for difficulties in developing cognitive and attentional processing. This heightened risk factor is directly related to alterations in the developing brain of the maltreated child. These alterations persist into adulthood; consequently, many creative individuals with very early trauma histories may struggle to regulate sensory stimuli and emotional arousal. Sadly, the dose effect of childhood maltreatment increases despair and suicidal thoughts and actions in mid-adulthood. Many of these highly maltreated children struggle throughout their lives to manage depression, anxiety, and interpersonal relationships. Studies demonstrate that creative individuals, in particular poets (See Poetry), suffer more mental illness and have higher suicide rates (Kyaga et al., 2013). Perhaps the factor that is mediating these elevated pathology patterns reported in creative individuals is the dose effect of cumulative trauma.

The subjective importance of *traumatic event centrality* directly influences both trauma-related symptoms and posttraumatic growth (Bernard et al., 2015). Childhood maltreatment may cast a long shadow into adulthood for some individuals or it may be muted with minimal negative outcomes. Efforts to minimize the negative effects of childhood maltreatment are more difficult when cumulative trauma increases, and even more so when there is a history of sexual abuse (Felitti and Anda, 2010). Equally troubling, many highly traumatized children manifest severe dissociative processing. Efforts to emotionally disengage (dissociation) from the hyperarousal states of intense fear often provoke perceptual states of depersonalization or derealization (Thomson and Jaque, 2019). A feeling of non-existence negatively influences the formation of a sense of self-identity. It alters access to autobiographic memory and diminishes optimal performance.

These experiences may also foster the inverse response; they may serve to increase motivation to climb out of these adverse environments and situations (Olszewski-Kubilius et al., 2015). For many talented children, family members or mentors may encourage their talent development. Although socioeconomic resources and stable family structures are optimal, family systems that are marginalized, such as families that are isolated or dissimilar from the social context in which they reside, may be freed from the normative values and conventions ascribed by that community (Olszewski-Kubilius et al., 2015). Children may be encouraged to pursue less traditional paths in order to realize their talents. Likewise, increased family stress, including rejection and neglect, may foster intrinsic motivation to succeed in order to gain acceptance, attention, or love. Children who experience parental loss, authoritative parenting, domestic violence, and other forms of maltreatment may intensify their efforts to succeed, along with building a tolerance for enduring adversity. As well, they may actively seek strategies to overcome their adversity (Olszewski-Kubilius et al., 2015).

Efforts to thrive despite marginality or hostility may be associated with innate giftedness or talent; these challenges may augment tolerance for ambiguity and uncertainty later in adulthood (Olszewski-Kubilius et al., 2015). Growing up in chaotic families and communities, including exposure to polyvictimization, provokes specific attentional shifting processes necessary to survive. Rather than developing skills to inhibit responses, maltreated children and youth must rapidly switch attention from one task or demand to another challenge (Mittal et al., 2015). Their environment is unpredictable and uncertain. This shifting attentional executive functioning survival skill may promote later success in adulthood, particularly in careers that are inherently unstable and require creative adaptive output.

Promoting Creativity and Cumulative Childhood Trauma

Children exposed to multiple forms of trauma require support and trauma-informed care in order to address a myriad of deficits and adaptations. The first step is to provide safety; in ideal situations the child's living conditions should not be fraught with violence and maltreatment (Thomson and Jaque, 2019). In these safe settings, the child's physiologic responses can stabilize; with more physiologic equilibrium greater self-regulation (emotional, behavioral, interpersonal) can emerge. The ability to engage more complex cognitive processing will increase flexibility and creativity, factors that are essential in problem-solving tasks (Cook et al., 2005). A greater sense of self-autonomy can also be nurtured, especially when a relational support group is cultivated.

Psychological processing of the traumatic events is possible once these safety factors are established. Often these conditions can be cultivated within the creative domains such as art, music, dance, and theater, or within sport settings. For example, engaging in the performance of music, regardless of musical genre, promotes self-awareness and self-understanding (Davis, 2010). While engaging in the creative arts or sporting activities, children and adolescents are given safety and an opportunity to acquire creative problem-solving skills. They can learn to regulate intense emotional responses and nurture relationships that promote positive self-appraisal, self-efficacy, self-worth, and self-esteem (Cook et al., 2005). These experiences foster opportunities to interact with companions that share similar experiences. Maltreated children who are offered these opportunities are able to engage in a supportive community; ideally these supportive communities will expand their reach to include others who were exposed to polyvictimization (Connell et al., 2018). Providing maltreated children with experiences of control and mastery offsets the risk of their potential withdrawal from challenging tasks. Often, maltreated children withdraw sooner

than non-maltreated children because they lack adaptive self-regulating skills, hence the need to nurture self-efficacy. Settings that promote creativity can facilitate perceptions of control and mastery; this may counter the uncertainty experienced during a childhood fraught with maltreatment (Mittal et al., 2015). All these experiences provide opportunities to establish a sense of meaning and purpose. By taking action, pursuing choices, or deepening a sense of spirituality, maltreated individuals can derive meaning from the suffering and hardships they endured; finding meaning has the potential to invigorate self-esteem and self-acceptance.

Conclusion

The devastating effects of childhood trauma are evident across all areas of development and persist into adulthood. The effect of exposure to maltreatment is toxic for the developing psychological and physiologic systems of children and youth. Solid evidence verifies the causal mechanisms of early adversity and later impairment. Research findings indicate that many adult diseases are actually developmental disorders that have their origins in early childhood (Turner et al., 2010). Even when children are provided with opportunities to engage creatively, the toll on their psychological and physiologic development is long lasting. Perhaps research studies that demonstrate higher incidences of mental illness (substance abuse, anxiety, depression, bipolar disorder, psychosis, dissociation, and suicidality) within creative populations are failing to account for the toxic strain that may have its origins in early childhood development (Connell et al., 2018). Studies that account for childhood adversity demonstrate that creative eminence is not fully associated with mental illness; rather childhood adversity increases the vulnerability for mental illness and may diminish the potential for creative output (Kyaga et al., 2013).

Healing complex trauma is often enhanced in creative expressive arts programs. Stress reduction is found to be greater among individuals who engage in one or several expressive arts programs (Thomson and Jaque, 2019). For individuals with high cumulative trauma exposure, evidence indicates that participating in the creative process is associated with heightened purpose. These individuals value the opportunity to make meaning while creating, they experience a sense of belonging in the universe beyond the limits of an isolated self, and they endorse a sense of transformational transcendence (Thomson and Jaque, 2019). For individuals with substantial childhood trauma, even when they achieve eminent status within their creative domain, the positive experiences derived while creating remain vital (Thomson and Jaque, 2019).

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Children's Creativity

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Introduction

Consider children's creativity and you may be reminded of a cardboard box transmogrified into a space ship, a pillowcase crafted into a super hero's cape, or a magical fort made-up of blankets strewn over strategically arranged dining room chairs. Supply children with crayons, paint, clay, paper, and scissors, and they will experiment and construct fantastical images and playthings. In fact, children will engage in pretend play, improvise songs and dances, tell stories, and make-up imaginary friends often without abandon or the need for 'toys' in such a spontaneous and natural way that it seems it go without question that children are creative. While it is easy to see that children are creative, it is also clear that their creativity is qualitatively distinct from the type of domain-changing creativity associated with eminent artists and scientists such as Beethoven, Maya Angelou, Albert Einstein, and Steve Jobs. In what follows, we address the nature of creativity seen in typical children, the methods for assessing this disposition, and the factors which impede and those that promote children's creativity. We write from the assumption that creativity, like intelligence, is domain-specific ([Gardner, 1983](#)), and that creativity is distinct from intelligence because any intelligence can be used in a more or less creative way.

The Nature of Children's Creativity

The standard definition of creativity focusses on product: a creative individual is someone who produces something novel and valuable within a domain – whether an intangible creation such as a theory, joke, or musical composition, or a physical production such as an invention, literary work or sculpture. This definition clearly refers to the kind of domain-changing creativity we refer to here as Big-C creativity. Although levels of creativity lie on a continuum, investigations of creativity have traditionally distinguished little-c creativity (the kind measured by standard creativity tests) and Big C creativity. Big-C creativity describes revolutionary contributions like Thomas Edison's invention of the light bulb and Picasso's invention (with Braque) of cubism; little-c creativity refers to more ordinary innovations such as repurposing leftovers for a new delicious meal.

Which of these do children demonstrate? Given that one must master a domain – said to take about ten years – before one can change it, then by definition no child can be Big-C creative. Typical children are little-c creators. Even child prodigies cannot be considered creative in the Big-C sense: Mozart's 5-year-old composition, *Minuet and Trio in G major*, was stunning for a 5-year-old, but it did not change the domain of classical music. Blaise Pascal's discovery at age of 12 that the interior angles of a triangle always add up to the sum of two right angles was equally stunning, but did not change the domain of mathematics since this concept had already been discovered. But, Mozart's and Pascal's childhood creativity are qualitatively distinct from the creative play seen in a typical preschool classroom, and this has led to the concept of mini-c creativity. [Beghetto and Kaufman \(2007\)](#) propose distinguishing the creativity of the average child from that of the prodigy (or amateur artist, in their terms) by calling that of the prodigy mini-c.

Unlike the Big/little categories, which focus on creative expression and production, the mini-c category emphasizes creative potential and the creative process; thus, offering a new standard for evaluating children's creativity. Mini-c creativity refers to "the novel and personally meaningful interpretation of experiences, actions, and events," to the "dynamic, interpretive process of constructing personal knowledge and understanding within a particular sociocultural context" ([Kaufman and Beghetto, 2009](#)). The mini-c concept aligns with the Vygotskian conception of creative development, which posits that all individuals possess creative potential that begins with an "internalization or appropriation of cultural tools and social interaction ... not just copying but rather a transformation or reorganization of incoming information and mental structures based on the individual's characteristics and existing knowledge" ([Moran and John-Steiner, 2003](#), p. 63). The mini-c category underscores the value of recognizing creative aspects associated with

the 'beginner's mind' like openness to new experiences, active observation, and willingness to be surprised, and explore the unknown (Richards, 2007). The mini-c category offers a level of specificity that can allow children's creative interpretations and ideations, as well as the associated behaviors and attitudes, to be recognized and nurtured by parents and educators (Kaufman and Beghetto, 2009). Although there has been some effort to develop a systematic coding frame for micro-level measurements of creativity (described later in this chapter), we do not yet have a standardized valid and reliable way of assessing mini-c creativity.

The Assessment of Children's Creativity

In 1957, the Soviet Union beat the United States into orbit by successfully launching Sputnik, the first artificial satellite. In response to this defeat, American psychologists developed a wide variety of tests to assess children's creative potential, specifically in science and math. Ever since, a plethora of tests have become available for assessing children's creativity at the level of the person, the creative product, and the process. A review of the literature on children's creativity shows that 80% most of studies employ measures on the level of the person or the product (Kupers et al., 2018). Clearly, more research is needed on the creative process.

Divergent thinking tasks are commonly used as indicators of creative potential, and most measures of children's creativity have focused on ideational fluency in which participants must generate as many responses as they can to a particular stimulus. An example of such a task is the Alternative Uses Task where participants are asked to list as many uses as possible for a common item. Responses are scored in term of originality (as compared to responses from other children), fluency (number of responses), flexibility (number of different categories), and elaboration (amount of detail).

The most widely used assessment of divergent thinking is the Torrance Tests of Creative Thinking, which includes a verbal section (Thinking Creatively with Words) consisting of six activities (asking, guessing causes, guessing consequences, product improvement, unusual uses, unusual questions, and just suppose) and a nonverbal section (Thinking Creatively with Pictures) consisting of three figural activities (picture construction, picture completion, and lines/circles). As is the case with the Alternative Uses Test, scores on the Torrance are based on fluency, flexibility, and originality.

Unlike the Alternative Uses and Torrance Tests, which are domain-general assessments of creativity, the Evaluation of Potential for Creativity is used to assess domain-specific divergent and convergent thinking via both verbal and graphic tasks appropriate for elementary through middle school students. The Evaluation of Potential for Creativity is domain-specific, with versions for artistic, literary, social, math, science, and music creativity (Barbot et al., 2011).

Despite their popularity, some creativity researchers have questioned the usefulness of divergent thinking tasks. Simonton (2003, p. 216) expressed concern that "none of these suggested measures can be said to have passed all the psychometric hurdles required of established ability tests. For instance, scores on separate creativity tests often correlate too highly with general intelligence (low divergent validity), correlate very weakly among one another (low convergent validity), and correlate very weakly with objective indicators of overt creative behaviors (low predictive validity)." Although new approaches to the assessment of divergent thinking have been proposed (e.g. top-2 scoring method, in which participants are asked to select their two most creative ideas, which then are evaluated for creativity; Silvia et al., 2008), these evaluations are still just snapshots of creativity that do not capture in real-time the core of creativity, namely the creative process.

Alternatively, Kaufman and Beghetto (2009) suggest self-assessments and microgenetic methods as more naturalistic and informatively rich approaches to pencil-and-paper measures of creative potential, argued to better illuminate the developmental process of children's creativity (mini-c). Self-assessments are useful because they require students to reflect on their own creativity, and thus can reveal how children think about their creativity. The microgenetic method combines close observations (typically video recorded) of children as they progress through developmental stages, and repeated measurements (such as asking children for immediate retrospective explanations of their thoughts and actions) over the course of time. This method has been previously used to study children's learning (Siegler, 2006), and could provide a detailed illustration of the development of a child's creativity by allowing researchers to identify and examine dynamic microlevel changes in psychological structures. Five specific dimensions can be examined through the microgenetic method: the path of change (is the change qualitative or quantitative?); the rate of change (is the change sudden or slow?); the breadth of change (is the change domain-specific or generalizable across domains?); the variability of change (how variable is a person's behavior across similar tasks within a domain?); the source of change (what do the changes in behavior, such as strategy use, suggest about the source of change?; Siegler, 2006). Researchers interested in using the microgenetic method to study children's creativity, could employ the coding system proposed by Kupers et al. (2018) which captures the two core components of creativity – novelty and appropriateness – on an ordinal four-point scale at each moment during the creative process. The coding frame follows three steps: first, researchers must determine the unit of measurement (the level of detail in which they wish to study the creative process), and they then code the units in terms of novelty and appropriateness. This measure is a preliminary and not yet validated, but could well serve as the state of the art in children's creative potential assessment by providing a fuller picture of what is provided by narrower, standard psychometric approaches.

The Development of Children's Creativity

Elsewhere, we have proposed that artistic development in children follows a U-shaped curve (Gardner and Winner, 1981), with preschool children's processes and product similar to those of adult artists, followed by a period between childhood and adulthood

characterized by literalism. Thus, children's drawings are at first playful, joyful, and unconcerned with the conventions of representation or realism. By middle childhood their drawings become more stereotyped as they master the conventions of the graphic domain and focus on the rules of realistic representation. By late adolescence, at least among those children who will become artists, conventions are now broken. Thus, the preschool child is pre-conventional; the adult artist is post-conventional. Most adults however never emerge from the literal stage. This three-stage model has been shown to fit both the development of drawing and of non-literal language use ([Gardner and Winner, 1981](#)).

We can draw a connection here to the stages of children's creativity: it has been argued that young children are more creative than (typical) adults. Both Pablo Picasso and John Lennon shared the belief that artistic impulse is strongest in the early years of life and often attenuates as a child matures. This sentiment is echoed in the most watched TED talk of all time titled "Do schools kill creativity?" in which educationalist Sir Ken Robinson argues that "we don't grow into creativity, we grow out of it." In fact, a longitudinal study examining creative capacity across childhood showed that when kindergartners were tested, 98 percent scored at the genius level in divergent thinking on the test employed by the National Aeronautics and Space Administration to select innovative engineers and scientists. The same children were re-tested when they were ten and 15 years old, at which point only 32 percent and 12 percent scored as high, respectively. Moreover, only a mere two percent of adults over the age of 25 demonstrated the same high level of creativity as the five-year-olds in the study ([Land and Jarman, 1992](#)). Kim (2011) found a similar trend of diminishing creativity with age; her analysis of the Torrance scores of 272, 599 kindergarten through 12th grade students and adults between 1974 and 2008 showed that since 1990, even as IQ scores grew higher, creative thinking scores have significantly declined, especially in kindergarten through third grade. These findings reveal that children have, over the years, become less able to generate many ideas, generate novel ideas, and elaborate on these ideas, and have become less intellectually curious and less open to new experiences.

Kim's study is based on the assumption that creativity is domain-general. However, a study by [Weinstein et al. \(2014\)](#) reported a decline in the creativity of adolescent writing since 1990, along with a rise in the creativity of adolescent visual artworks (as assessed qualitatively rather than by a standardized creativity test). Findings like Kim's as well as Weinstein et al.'s underscore the need to discover the factors that impede (as well as promote) children's creativity.

Factors Affecting Children's Creativity

This loss of creative potential may result from external factors such as pressure to think and behave according to conventions. This loss might also reflect internal factors such as an increase in reasoning skills and executive functions, which also takes place around this age and which may interfere with the free play of imagination.

Externally Caused Factors

One factor that may be impeding children's creativity is the emphasis on rote learning and standardized testing in schools. This focus stands in direct contrast to play. Beginning at about eighteen months, children engage extensively in pretend play, which may serve as practice for the types of imaginative thinking observed in the creative activities and innovations of adults. Play – whether physical, constructive, imaginative, dramatic, or games with rules – is the primary way that humans learn to understand and experience the world. Yet, instead of prioritizing play, the focus and investment on narrow high-stakes standardized testing in schools has left little time or resources for children to employ their creative potential.

A second factor that has been shown to impede creativity in children (as well as adults) is the extrinsic motivation to get a good grade or win a competition. Research has shown that intrinsic motivation is important for creativity, and that extrinsic motivation is a strong impediment.

A third factor may be parental focus on obedience. Being creative requires taking risks. Creative people innovate novel ideas that may be criticized, ridiculed, or ignored by audiences. In fact, creativity is most strongly associated with social risk-taking (i.e. the willingness to challenge norms), which can be an ostracizing experience. If creativity is to develop, it must be encouraged by caring others in a supportive environment. However, research shows that child obedience is valued over independence by parents in nations where poverty and lack of education prevail. Given that creativity necessitates risk-taking and sometimes rule-breaking, it follows that children living in poverty may face an impediment to their creativity from parenting practices that foster obedience and conformity. Additionally, children from low-income households often attend Title 1 schools – institutions with large concentrations of low-income students that adhere to rigid classrooms and high-stakes standardized tests. Furthermore, the No Child Left Behind Act and Common Core Standards Act caused schools to focus their resources on subjects like reading and math to achieve high scores on statewide standardized tests. As a result, arts classes (which are more likely to develop creativity than classes requiring rote learning) received less funding, leading to fewer arts opportunities in schools. The consequence of these budget cuts is less detrimental for students who live in affluent communities and receive the benefits of arts education through extracurricular programs, which may be cost-prohibitive for low-income children.

External factors may also be used to *promote* creativity – specifically a focus on play. Research has shown that children who participated in flexible play experiences showed significantly greater creativity on the Torrance than children participating in highly structured play experiences. Consistent with these results, [Garaigordobil and Berrueto \(2011\)](#) found verbal and graphic-figural creativity of preschoolers, and 10- and 11-year-olds improved significantly from a weekly 75-min or two-hour play session throughout the

academic year. Dansky and Silverman (1973) found that children who were given the opportunity to play with objects gave significantly more uses for those objects than did children in the control condition who did not get a chance to play with the objects beforehand; findings from this study highlight the importance of play as a means of encouraging divergent thinking and reducing functional fixedness (a cognitive bias that limits one's mental representation of an object to that object's typical use).

Internal Factors

An internal factor that has been shown to impede creativity in adults is strong cognitive control. Cognitive control, the ability to limit attention to goal-relevant information, subserves higher-order cognitive functions such as reasoning, attention, planning and organization. Counterintuitively, deficits in these functions have proven advantageous in certain contexts: low cognitive control means less filtering of attention, and such unfiltered attention leads to novel solutions in creative problem solving contexts. For example, young children have weaker cognitive control than do older children, and have also been found to solve creative problems better than older children (German and Defeyter, 2000). In addition, when cognitive control is compromised because of Attention Deficit Hyperactivity Disorder, age, fatigue, intoxication, and disruption of the pre-frontal cortex due to transcranial direct current stimulation or lesions, the ability to "think out of the box" is enhanced. In short, impaired cognitive control in adults is associated with heightened creative thinking, and we are now investigating the possibility that children with low cognitive control (often a result of the stress of poverty) have enhanced creative abilities. Paradoxically, thus, schools' attempts to enhance cognitive control may have the unintended consequence of dampening creative potential.

Conclusion

In this chapter, we reviewed research showing that while children demonstrate little-c creativity across a variety of domains, a focus on mini-c may help to shed light on the *process* of children's creativity. A decline of creativity in mid-childhood, "the fourth-grade slump," may be a consequence of education systems and child rearing practices that value obedience over play.

As globalization and technological developments accelerate, we face unprecedented social, economic and environmental challenges. In order to successfully navigate the uncertainties of the future and solve unpredictable problems, our children will need to develop their creative capacities. Accordingly, the Organization for Economic Cooperation and Development, United Nations Educational, Scientific and Cultural Organization, and Partnership for 21st Century Skills have identified creativity and innovation in problem-solving as fundamental employability skills. Considering that corporate executives and public sector leaders worldwide cite creativity as the most important leadership quality for success in business, today's children would be best served by rearing practices and curricula that nurture the development of their creativity.

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Climate[☆]

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Glossary

Climate Perceptions of environment

Dimension A certain feature or attribute of the work environment

Inter-judge Agreement Agreement among multiple people as to attributes of work environment

Levels Perceptions of climate vis-à-vis different units in the work environment

Moderators Variables that change the effects of climate perceptions on performance

Work Climate Perceptions of attributes of work environment

Climate

Creative work, the production of original, high quality, and elegant solutions, to complex, novel, ill-defined, or poorly structured problems requires people to invest substantial resources, both cognitive and emotional resources, in their work. In fact, prior studies have shown that motivation to solve the problem at hand, confidence in one's ability to solve the problem, and the relevance of solving the problem to one's personal and professional self-image, or identity, all influence people's investment of cognitive resources in solving creative problems—and, their subsequent success in solving creative problems.

The importance of motivation for creative work cannot be disputed. One must remember, however, that people must also make a decision to invest scarce resources in creative work. Often, people's perception of the environment in which creative work is to occur leads them to believe that a creative problem cannot be solved or, if solved, their efforts will not be rewarded. Thus, people make a decision based on their perceptions of their work environment as to whether they will invest resources in solving creative problems.

Recognition of this point has led to an interest in the nature of the environment that encourages people to undertake creative work—solving the kinds of problems that call for creative thought. In the present effort, we will examine the various models that have been proposed which seek to describe the kind of work environments that encourage, or discourage, creative thought. This chapter examines how the variables specified in these models influence creative performance and the variables that act to moderate these effects. Finally, we will consider how institutions might go about establishing a climate likely to encourage people to invest in creative problem-solving.

Psychological Climate

At first glance, it seems rather easy to identify attributes of people's work environment. One might just observe the environment, however, people see, and attend to, different aspects of their work environment. The environment one person "sees" may not be the same as the environment other people "see". Thus, in a work group, while some people might endorse the statement "people in my work group are rewarded fairly", others might not endorse this statement. Put differently, the environment is in the eye of the beholder. Accordingly, many scholars have argued that climate must be measured through people's perceptions of their work environment.

[☆] *Change History*: August 2019. Michael Mumford updated the text throughout the article.

This article is an update of T.L. Friedrich, C.K. Stenmark, M.D. Mumford, Climate for Creativity, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 208–213.

This apparently straightforward observation, however, raises three key questions bearing on any study of climate. First, what attributes, or dimensions, of the environment are people perceiving? Second, what is the significance of these perceived attributes of the environment for people's performance? Third, how do we know it is really the environment people are perceiving – might it just be their personality?

There is a straightforward answer to this third question. James (1982) has argued that climate, an environmental event, can be assumed to exist when multiple people agree about the existence of this event. Thus, if people working in a common environment, or on a common task, all agree an event occurs, we attribute their responses to a question, for example, "safety procedures are clearly described" to the environment—not their unique personality.

The need to establish agreement with respect to attributes of a certain work environment has another noteworthy implication. An explicit definition must be provided as to who might, or might not, share a common work environment. Thus, a study of service climate at a telecommunications firm may have little to say about service climate at an energy firm. Moreover, agreement may not be constant across different levels in a firm (e.g. managers versus workers) and it may not be constant across different units within a firm where the same work is occurring.

Assuming one can demonstrate agreement, a new question comes to fore – agreement with respect to what? Environments, including the environments people perceive, are complex, multifaceted, entities. Thus, Schneider (1980) talks about service climate and Zohar (2010) talks about safety climate. Each model is examining agreement with respect to certain attributes of the work environment where these attributes of the work environment are held to impact certain outcomes, or certain forms, of the performance of interest. Thus, a key question in all climate studies is, exactly what are the attributes of the environment that are relevant to the outcomes of interest?

Of course, our foregoing observations broach a new key question of concern in studies of psychological climate. If more, or less, of an environmental attribute is perceived by people working in an environment, is this attribute related to the performance of interest? This question, moreover, may be extended to the conditions under which these relationships are observed—moderators, or conditions under which, climate attributes are related to the outcomes of interest.

When attributes of the environment impacting performance have been identified and the conditions under which these relationships are observed have been specified, we can identify actions to take on this environment to bring about certain outcomes. Environments are not fixed but can be changed. In fact, the desire to establish work environments likely to encourage creative problem-solving underlies our interest in creative climate.

Climate Models

Of course, many attributes of the environment might act to influence creative problem-solving. Thus, if one believes autonomy is important, one might ask people to indicate whether "people in my workplace have the freedom to pursue ideas they believe to be important". If one believes peer support is important, one might ask people to indicate whether "my coworkers will provide me with ideas to help me solve problems I am encountering in my work". If one believes resources are important, one might ask people to indicate whether "we have the equipment needed to pursue work on our projects".

The foregoing questions not only illustrate the types of questions asked in creative climate inventories, they also point to a broader issue. Exactly what attributes of the environment are of concern in accounting for creativity? And, over the years, multiple models of creative climate have been proposed with different theoretical models being used to specify different attributes of the environment that might contribute to creative problem-solving. Broadly speaking, these various models appear to be based on one of two meta-theoretical frameworks: 1) psychological and 2) organizational.

In the psychological model, environmental conditions which would encourage an individual to invest resources in creative work are used to specify climate attributes. Thus, Amabile et al. (1996) argued social supports are crucial for such investments, leading them to hold that perceived work group support, challenging work, supervisory encouragement, freedom, and sufficient resources, among other dimensions, would contribute to creativity. Ekvall and Ryhammar (1999) take a different approach, arguing a creative environment is an environment which allows people to express their creative personality. Thus, they propose climate dimensions such as playfulness and humor, trust, freedom, challenges, and risk-taking among other dimensions.

In the organizational model, attributes or specific features of the work environment are used to specify the attributes of concern. For example, Anderson and West (1998) argued that in the "real-world", most creative work occurs in teams. Their understanding of team interactions was used to propose a climate model which includes four attributes: 1) participative safety, 2) support for innovation, 3) challenging objectives, and 4) task orientation. Abbey and Dickson (1983), in contrast, argued creative work occurs in new product development efforts and the characteristics of new product development efforts led them to propose climate dimensions such as cooperation, reward system, status polarization, structure, and flexibility.

Of course, other psychological (e.g., environmental attributes contributing to creative self-efficacy), and organizational (e.g., environmental attributes contributing to organizational learning) attributes might be used to specify still other climate models. By the same token, these models do specify certain common attributes, attributes of the environment, consistently held to contribute to a climate for creativity.

Hunter et al. (2005) reviewed the various models of creative climate, both psychological and organizational models that have been proposed over the years. In this review, explicit operational definitions of each climate variable were obtained. Judges then classified those climate variables into general categories with high levels of inter-judge agreement being observed in final category assignments. They identified 14 attributes, or dimensions, commonly found in models of creative climate including 1) positive peer group, 2) positive supervisory relationships, 3) adequate resources, 4) task challenge, 5) mission clarity, 6) autonomy, 7) positive

interpersonal exchanges (e.g., trust), 8) intellectual stimulation, 9) top management support, 10) rewards provided, 11) flexibility and risk-taking, 12) production emphasis, 13) participation, and 14) organizational integration. This 14-dimensional model of creative climate was found to account for more than 90% of the dimensions proposed in earlier models of creative climate.

These environmental attributes allow items, or markers, of each environmental attribute to be formulated—for example, “my colleagues provide useful feedback on project work” or “all members of my work group are encouraged to express their ideas”. When multiple environmental markers of each dimension are identified, adequate internal consistency coefficients are obtained. Moreover, members of work groups agree in how they describe their environment. And, finally, factor analyses show the targeted dimensions, in fact, are those that emerge in examining the relationships among markers and climate dimensions.

Climate and Performance

A key issue remaining, however, is whether differences in people’s exposure to those environmental attributes are positively related to creative performance. In all, some 42 studies have examined the relationships between people’s descriptions of their work environments on these dimensions and subsequent creative performance. Hunter et al. (2007) conducted a meta-analytic study to examine, across studies, the impact of these environmental attributes on creative performance.

The first question, of course, is whether climate perceptions, in general, across all climate dimensions examined, are positively related to creative performance. It was found a more positive climate, in general, was positively related to creative performance yielding a Cohen’s d of 0.75—note d ’s below 0.40 are considered small, d ’s between 0.40 and 0.60 reflect an effect of moderate impact, and d ’s above 0.60 a sizable positive effect. Notably, it was found these effects held when both objective indices, for example—patent awards, and subjective evaluations of creative performance, for example—superior’s appraisals of creative work, were used as the measure of creative performance. Thus, the impact of climate on creative performance evidences good cross-criteria generality.

Of course, one question that might arise with regard to these relationships is whether they are conditioned by certain features of the study design in use—a question of internal validity. Hunter et al. (2007) also coded the studies under consideration with respect to various features of the design employed such as sample size, location of publication (peer or non-peer reviewed), and use of a standardized climate measure or an in-house, locally developed, measure. Broadly speaking, the findings they obtained indicated that the predictive value of climate measures in accounting for measures of creative performance generalized across these study design considerations with two notable exceptions—first, if the study was obtained from a peer-reviewed ($d = 0.86$) as opposed to a non-peer reviewed publication ($d = 0.59$) and if a standardized climate inventory was employed ($d = 1.00$) as opposed to a locally developed, “in house”, inventory ($d = 0.63$).

Given the generality of the impact of climate measures on creative performance, a new question comes to fore—a question of some importance to students of creativity. What climate dimensions, what attributes of the person’s work environment, exerted the strongest effects on creative performance? To address this question, Hunter et al. (2007) asked judges to assign each climate dimension to one of the 14 general climate dimensions described earlier and Cohen’s d ’s were obtained for each dimension.

The findings obtained in this analysis indicated that all 14 climate dimensions were positively related to subsequent creative achievement producing Cohen’s d ’s between 0.48 and 0.91 across the 9 to 30 studies where this dimension was examined. Although other climate dimensions might exist that influence creativity, it seems clear these 14 dimensions, in fact, do influence creative performance.

However, not all these dimensions were equally important. The seven dimensions producing the strongest relationships were 1) positive interpersonal exchange ($d = 0.91$), 2) intellectual stimulation ($d = 0.88$), 3) task challenge ($d = 0.85$), 4) flexibility and risk-taking ($d = 0.78$), 5) top management support ($d = 0.75$), 6) positive supervisory relationships ($d = 0.73$), and 7) positive peer group ($d = 0.68$). The seven dimensions producing the weakest relationships were 1) autonomy ($d = 0.48$), 2) adequate resources ($d = 0.51$), 3) rewards provided ($d = 0.55$), 4) production emphasis ($d = 0.59$), 5) organizational integration ($d = 0.62$), 6) participation ($d = 0.62$), and 7) mission clarity ($d = 0.61$).

These findings, taken as a whole, point to the key characteristics of a creative work environment. A creative work environment is one where people are presented with challenging, intellectually stimulating assignments where they are encouraged to take risks under conditions where they have support—support from peers, supervisors, and top management. Autonomy, resources, rewards, and participation although helpful, are less important than intellectual challenge and support.

Moderators of Climate

Having shown climate perceptions are strongly positively related to creative performance, a new question arises. What attributes of the people, or the context in which the work is being done, act to moderate the relationship between people’s perceptions of their work environment and creative production. One key variable in this regard is the professionalization of the workforce and management of workers with respect to professional practices. In keeping with this observation, Hunter et al. (2007) found that climate exerted stronger effects on creative achievement when climate’s impacts were studied in professions (e.g., engineering, medicine) as opposed to non-professional (e.g., sales, management) occupations. These effects appear to arise both because professionals are expected, as part of their work, to generate new ideas and viable creative problem solutions while they are given some discretion

as to how their work is to be completed. When professionalization, idea generation, and discretion with regard to how work is to be completed are all high, one should expect climate perceptions to have a stronger impact on creative performance.

Another set of moderators that act to condition the impact of climate perceptions on creative performance may be found in characteristics of how teams work together in solving creative problems. Broadly speaking, attributes of teams that act to induce conformity seem to diminish the effects of climate on creative achievement. Thus, high interdependence, substantial cohesion, and strong shared mental models for understanding the problem at hand all seem to act to diminish the effects of climate on creative achievement. Not all team level variables, however, necessarily inhibit the impact of climate on creative achievement. Teams that are reflexive, meaning that they think about why actions worked or did not work, result in climate perceptions having stronger, not weaker, effects on creative achievement. Along somewhat different lines, when team members come from a number of different professional backgrounds, functional diversity, climate perceptions have been found to exert stronger effects on creative achievement.

Creative work, moreover, requires resources and access—access to others and access to institutional decision makers. In fact, prior work indicates that active external communication and diverse networks of contacts contribute to creativity. More centrally, information access, and the need for access to a diverse pool of information, seems to strengthen the relationship between creative climate and subsequent creative achievement. Along similar lines, a lack of resources, time, equipment, and money, can inhibit creative achievement. Again, more centrally, the availability of resources has been found to result in a stronger relationship between creative climate and creative performance.

Sharfman and Dean (1991) have characterized institutional environments with respect to four key variables—capital intensity, turbulence, competitive pressure, and production pressure. Hunter et al. (2007) examined how these variables act to moderate the impact of creative climate on subsequent creative achievement. They found that capital intensity, the need to protect extant investments, acted to attenuate the effects of creative climate. However, the effects of creative climate on subsequent creative achievement became stronger when there was substantial turbulence in the technical environment and intense competitive and production pressure.

These observations are noteworthy because they paint a rather compelling picture of when a creative climate must be established to ensure creative production. When a team of diverse professionals is working in a technically turbulent arena with adequate resources but under intense pressure where conformity is neither desired, or enforced, in the approaches to be taken to problems, then, under these conditions, creative climate will have an especially strong relationship with the production of creative problem solutions and the production of innovative, new, products.

Establishing Climate

James et al. (1990) have shown that the actions taken by leaders are the most powerful influence shaping peoples' perceptions of climate. In keeping with this observation, Isaksen and Akkermans (2011) have described the many actions that might be taken by leaders to improve climate perceptions among those doing creative work. For example, leaders can encourage all team members to voice their ideas. Leaders should expressly recognize the creative accomplishments of team members. Leaders must encourage risk-taking, the pursuit of new ideas, and not punish team members if their ideas do not work out.

Although these, and other actions, by leaders are important to establishing a creative climate, Mumford et al. (2002) argued leaders play three other key roles in establishing a viable creative climate. First, it is the leaders of creative teams who acquire top management support, and requisite resources, for creative efforts—both noteworthy influences on creative climate. Second, leaders establish, and model, appropriate interactions among team members and leaders' modeling of appropriate interaction patterns has a noteworthy impact on peer support. Third, leaders establish the missions to be pursued by teams, and provide team members with technical feedback regarding their work. Thus, leaders establish the challenge confronting teams and help shape an intellectually stimulating environment—and, as noted earlier, both challenge and intellectual stimulation are two of the more important dimensions contributing to perceptions of a creative climate and creative performance.

Leaders and team members, however, both contribute in another way to establishing a viable creative climate. When team members are engaged in the task at hand, active intellectual exchange of ideas and technical, albeit not personal, critiques of ideas will emerge. And, this active, often critical, albeit supportive, intellectual exchange appears to be a key influence on establishing a creative climate. Such exchanges not only ensure the deep criticism found to contribute to creative problem-solving, they also build a sense of creative self-efficacy.

Yet another way one might go about establishing a creative climate is to stress the value of learning with respect to the fundamental concerns at hand—learning that may emerge as much from failure as success. By stressing learning, of course, risk-taking and flexibility are likely to be perceived as noteworthy aspects of the work environment. Moreover, actions that encourage a learning orientation in teams also contribute to feelings of psychological safety. Carmeli et al. (2010) have shown that feelings of psychological safety are a key variable contributing to performance on creative tasks.

Conclusions

Our foregoing observations point to a broader conclusion of some practical significance. The study of creative climate is of substantial practical value because it tells us something about how institutions should seek to manage those it is asking to pursue creative work. Establishing an environment that people perceive as challenging, intellectually stimulating, and supportive is apparently one

key mechanism by which institutions can encourage creative achievement. In fact, when professionals are asked to work on complex, new, or emerging problems, the problems encountered in turbulent environments where production pressure is real, climate perceptions become an especially important influence on subsequent creative achievement. We hope the present effort provides an impetus for future work intended to identify the most effective ways of establishing the kinds of work environments most likely to encourage creative achievement.

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Cognitive Style[☆]

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Glossary

Cognition The process of perceiving, recording, storing, organizing, and using information

Cognitive ability Efficiency in the processing and storage of information

Cognitive strategies Systematic methods people use to process information and solve problems

Cognitive style Consistent individual differences in the ways people experience, perceive, organize, and process information

Mediator A given variable may be said to function as a mediator to the extent that it accounts for the relation between an explanatory variable and a dependent variable

Moderator A moderator is a human characteristic variable that affects the direction and/or strength of the relation between an explanatory predictor variable and a dependent variable

Personality trait Consistent individual differences in dispositions for specific classes of behaviors

Validity Correspondence between what test scores purport to measure and what they actually measure

The Construct of Cognitive Style

Cognition embraces the whole spectrum of human information processing, including perception, memory, language, learning, thinking, problem solving, and creativity. Systematic individual differences in such modes of information processing have been construed as dimensions of thinking, learning and intellectual styles.

The term 'style' designates a preferred way of doing things. Hence, cognitive style can be defined as consistent individual differences in the ways people prefer to organize and process information. A number of style theories and operational definitions of cognitive style exist. They have focused on a person's typical mode of cognition as reflected in: his or her main dispositions in *perception*, the organization of information in *memory*, the preference for different kinds of general *problem-solving strategies*, the speed and accuracy of *decision making under uncertainty*, the preference for different types of *problems to solve*, etc. Some of these distinctions describe preferences for different approaches to dealing with the challenges involved in creativity.

While such concepts may appear fairly straightforward, the construct of cognitive style has nevertheless been associated with several problems. The more important of these can be grouped into seven major issues.

First, most style researchers have made a distinction between cognitive styles and cognitive abilities. While cognitive styles are defined as describing *how to*, or in what way we process information, cognitive abilities are defined in terms of *how well* we process information. Cognitive abilities capture how much, how well, or how accurately we process visual, semantic, or numerical stimuli. They are rooted in structural conditions that do not leave much room for choice. In contrast, cognitive styles describe differences in preferences to process information in certain ways and are anchored in functional conditions that provide more room for choice in, for example, the types of general strategies we tend to employ when working on problem solving tasks. Cognitive style may also determine whether we primarily perceive wholes or parts in dealing with tasks of problem solving, learning or creativity.

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Lack of, or low, correlation between style and ability has commonly been seen as a necessary condition for a style construct to be valid as the two should be related. Certain tasks suit certain styles: brighter people may be able to adapt their style to suit the nature of the task. Further, preferences possibly grow out of abilities. Thus, a facility with numbers may lead to a preference for convergent thinking, while a facility with words may lead to a divergent thinking style. Not all the postulated style constructs have, however, controlled for influences from abilities. Some style constructs have also been shown to have very high correlations with measures of abilities, which puts them in serious jeopardy in terms of fundamental construct validity – that is the two are essentially indistinguishable.

Second, there is the issue of the relationship between cognitive style and personality. Thus, dispositions based on the traits may influence us toward using certain modes of information processing, unless the task demands in the situation ‘forces us’ into other modes of processing. For the concept of a style to exist as an autonomous entity there must be incremental validity in terms of accounting for variance beyond what is explained by relevant personality factors. Under these conceptual requirements, the construct of cognitive style can be described as being placed at the intersection between personality and cognition. In this capacity it may serve an important function as a *bridge concept* that may bring personality and cognition together in a concerted way to optimize performance. Indeed, this is how the concept was initially conceived over 80 years ago. An implication of this is that several cognitive styles should be more strongly related to various personality constructs than to intelligence, and that style should be seen as a disposition as well as a situational preference. Very few, if any, style studies have controlled adequately for the effects of personality in the predictions of performance on cognitive tasks.

Third, there is the issue of a distinction between *task specific* strategies versus more general, higher order strategies, sometimes called *meta-strategies* or *executive functions*. Most researchers in the field have opted for the latter option. An implication of this is that styles should be relatively more consistent across tasks and stable over time, than task-specific cognitive strategies. This issue has, however, received relatively little attention in research on cognitive styles.

Fourth, there is the issue that style theories have flourished without being part of any unifying model or framework for the several style constructs. Some progress has nevertheless been made in this regard. Elena Grigorenko and Robert J Sternberg suggested a conceptual framework where styles could be placed under the headings *Cognition Centered* approaches (including style theories that relates to cognitive abilities), *Personality Centered* Approaches (including style theories that relates to personality traits or related constructs), and *Activity Centered* Approaches (including styles that relate to learning and teaching). Richard Riding and Stephen Rayner described a theory where a large number of cognitive style constructs are organized under two superordinate style dimensions called Verbalizer–Visualizer and *Analyst–Wholist* styles. The first of these describes typical modes of mental representations and the second pertains to the way in which the individual organizes information.

Beyond this, Li-fang Zhang and colleagues have suggested that style theories can be classified as *Type 1* (preference for unstructured tasks, norm breaking and original thought), *Type 2* (preference for structured tasks, conformity, respect for rules and authority), and *Type 3* (situation specific adaptability of Type 1 and Type 2 styles). Finally, Maria Kozhevnikov has argued that most style constructs could fit into a model with two dimensions: *superordinate* dimension was seen as related to executive cognitive functioning (associated with flexibility in the choice of lower level strategies), and (at least) two *subordinate dimensions* seen as describing either low-level information processing (like perception) or more complex cognitive activities (like decision making). However, currently no agreed upon general typology of cognitive styles yet exists.

Fifth, there is the question of whether style should be defined as being unipolar or bi-polar. In the former case, the two ends of a style continuum should be associated with opposite characteristics. People located in between the extreme scorers are seen as being more flexible or mixed in their dispositions. Bipolarity can be inferred to the extent that there is a relatively strong and negative correlation between the two polar opposites. Related to this issue is also the position taken by Eugene Sadler-Smith that, for example, intuitive-analytical cognitive styles actually describe two different cognitive processes, with a versatile style combining the two. Similarly, Chris Allinson and John Hayes posited that the *Analytic–Intuitive* dimension describe two poles on a continuum. A further distinction is described as *Mobility–Fixity*, where mobile dispositions describe a tendency to use both styles, whereas fixity describe a tendency to use only one. Associated with the bipolarity issue is also the assumption that both poles of stylistic constructs should in a general sense be value free.

Sixth, there is the issue of whether cognitive style theories should operate as *self-contained* models or as derivatives of more *general theories* of cognition and eventually also linked to theories of personality or abilities in a broader perspective. The latter alternative implies that styles should be defined in ways that make their operationalizations meaningful beyond the style construct itself. This has not always been the case for style theories, and a large number of theories have been formulated based on loosely defined ideas. Still, Samuel Messick made important strides in anchoring conceptualizations of cognitive styles more firmly and suggested that styles evolve around underlying profiles of abilities, traits, or motives. Moreover, while styles can be quite substantially influenced by both ability and personality, they should also be seen as shaped by individual experiences and adaptations. Robert Sternberg formulated a theory where styles are part of his more general theory of Mental Self-Government, and where styles describe different ways of using one’s abilities. Moreover, Øyvind L. Martinsen and colleagues developed a theory where style has developed based on a profile of personality traits and where style is seen as task-specific competencies and integrated with Herbert Simon’s information processing theory and the classic theory of achievement motivation to predict performance. Along similar lines Maria Kozhevnikov suggested that cognitive styles typically describe dispositions towards using different kinds of heuristics that we use to process information about our environment.

Seventh there is the question of whether styles are *trait-like* and relatively unchangeable, or *state-like* and adaptive based on situational constraints, training, or development. Elena L. Grigorenko has speculated about whether styles are stable and share some of

the genetic influence on intelligence and personality but pointed out that genetic research on styles remains nonexistent. In a recent comprehensive review of research on intellectual styles, Li-fang Zhang argued that at least some styles can be modified, but also that there is a lack of longitudinal studies that can support this idea. The question remains open.

Despite the challenges associated with the seven issues above, cognitive style has been a popular construct in psychological and educational research. Since the early 1950s and earlier, a large number of studies on style constructs have been published in journals and in edited and authored books. A number of these have touched on the *relationship between cognitive styles and creativity*. Moreover, several theories have been postulated over the years, and cognitive style has indeed been looked upon as an interesting construct within the field of creativity. The main reason for this is that it has been seen to have the potential to supply some of the missing pieces of the puzzle from the classic experimental research on human cognition. Here individual differences generally have been perceived as irrelevant or as a 'nuisance' in terms of unexplained variance. The construct of cognitive style has been used to describe *how* individuals process information in different ways and to show that the inclusion of such individual differences adds to our knowledge of human cognition beyond the reaches of both classical experimental research and multivariate studies of intelligence or personality. As regards the relationships among cognitive styles, creative problem solving and creativity, an important issue has been to investigate whether people solve problems or create novel and useful solutions in predictively different ways.

Below, we briefly present a number of style constructs, that seem to be most closely linked to the issue of creativity.

Theories of Cognitive Styles and Their Relationship to Creativity

Field Dependence–Independence

In 1954 research was initiated on field dependence and independence as a stylistic construct. This construct was defined as a perceptual variable, representing the degree of autonomous functioning in assimilating information from the self and field. Field dependence–independence was defined as a bipolar construct. Field-independent people excel at cognitive restructuring, while field dependent people are more socially adept because they are more sensitive to external referents. Moreover, field-dependent and field-independent types could be *fixed* (those who appeared not to have any capacity for the properties associated with their opposite style), or they could be *mobile* (those who appeared to be more flexible with regard to the two types of styles). Thus, some people were seen as more flexible than others with respect to their stylistic dispositions.

These stylistic properties were measured with two different tests. One was the Rod and Frame Test, where the task involved ignoring a visual or postural context to locate a true vertical. The other was the Embedded Figures Test, where the task involved locating a previously seen simple figure in a new figure where the simple figure had been embedded within a more complex design.

Results from several studies supported the hypothesis that field-independents are more creative than field-dependents, also in studies that controls for intelligence. Previously, it was also argued that mobile Field Independents would be more creative because of their ability to move flexibly between the two stylistic modes. This has been supported by recent research.

It is nevertheless necessary to interpret these results and ideas cautiously given the present conceptual status of the theory of field dependence–independence. Serious criticism has been raised against this theory, e.g., the frequently found high correlations with measures of general mental ability and, particularly tests of spatial ability. Based on such findings the status of the concept as a genuine style construct is uncertain.

Reflectivity–Impulsivity

This cognitive style dimension relies on differences in decision speed under conditions of uncertainty. Its primary measure was the Matching Familiar Figures Test, where individual differences in speed and accuracy of decision making (conceptual tempo) under uncertainty were measured. Time to make decisions and errors in the accuracy of decisions were combined to categorize children as *impulsives* or *reflectives*, or more precisely as *fast-responding/high-error*, *fast-responding/low-error*, *slow-responding/low-error*, or *slow-responding/high-error* types.

The study of the relationship between reflectivity–impulsivity and creativity has provided mixed results. No significant differences were found among conceptual tempo groups on a series of common creativity and problem-solving tasks. It has, however, been shown that fast/accurate and slow/inaccurate subjects obtained greater originality scores than slow/accurate and fast/inaccurate subjects. Significant relationships also have been obtained between reflectivity–impulsivity and some facets of musical creativity, and reflective subjects have been shown to score higher than impulsive subjects on the Torrance Tests of Creativity. Although no clear pattern in these findings has emerged, where significant relationships have been obtained, reflectives have had higher scores.

Holist – Analytic Theories

In Richard Riding and Stephen Rayner's organization of style theories a number of style constructs have been placed in the Holist-Analytic category that bear clear relevance to creativity. Among these, the style theory advanced by Michael Kirton in 1976 has made a special contribution to the study of creativity. In this theory *Adaptors and Innovators (A-I)* are seen as describing two qualitatively different and consistent individual approaches in preferences for different ways of solving problems and approaching tasks involving creativity and in decision making. Kirton makes a distinction between *style* and *level of creativity*. Level of creativity is

measured through evaluation of the quality of people's creative ideas or products. Style of creativity is supposed to capture the different approaches of adaptive creativity directed toward improvements within an existing framework, compared with innovative approaches directed towards basic change of the existing state of affairs. However, individuals are not seen as being fixed at either end of the A-I continuum, and when individuals depart from the behavior associated with their preferred style this has been called 'coping behavior.' It is argued that differences along the adaptive-innovative continuum should be unrelated to variations in the level of creative performance.

In several studies, it has been demonstrated that the Kirton Adaptor-Innovator inventory (KAI) does not correlate with measures of intelligence. Yet there is a relatively strong relationship has been obtained between scores on several personality traits and the KAI, for example, between KAI scores and the sensation seeking trait. Other researchers have found that the A-I continuum is positively related to Extraversion and Openness, and negatively to Neuroticism and Conscientiousness in the five-factor model of personality. Yet, there seems to be a need for studies showing that the KAI adds to prediction of creativity (incremental validity) by abilities and personality.

As regards creativity, research shows that KAI scores are generally uncorrelated with measures of divergent thinking. This has been taken as support for the idea that there are different types of creativity along the adaptive-innovative dimension that are independent of level of creativity. Generally speaking, however, zero correlations as such do not support the hypothesis that there are different types of creativity. Self-reports on both style and creativity evaluations do not necessarily support this idea. Moreover, a study by Robert Dew from 2009 suggests that Adaptors may be more motivated to be creative when creativity is perceived as useful, thus suggesting that the relationship between this style dimension and creativity depends on motivational cues in the situation.

Although Kirton's theory is interesting, the bulk of research on the theory is correlational or factor analytic. This implies that some of this research may lack the necessary controls to permit making causal inferences. This is a limitation when it comes to testing the main hypothesis in the adaption-innovation theory. Further efforts should thus be made to demonstrate experimentally that A-I indeed utilize qualitatively different strategies uncontaminated by level of creativity, and that these strategies have different implications for the direction of effort in creativity, problem solving, and decision making. Kirton's idea of a distinction between the style and the level of creativity is useful, but the support for this idea is so far too limited to warrant such a conclusion. Arguments have also been presented to the effect that the distinction may be conceptually flawed. Specifically, it has been argued that the concept of innovation/innovative logically requires the concept of creativity to be involved, whereas the concept of adaptation/adaptive does not.

Another theory in the holist-analyst category of styles is the theory of *Assimilator-Explorer (A-E)* cognitive styles which has been proposed by Geir Kaufmann and later elaborated by Øyvind Martinsen and colleagues. The theory of A-E styles describes individual differences in dispositions toward using problem solving strategies. Kaufmann based his original theory on cognitive schema theory with special reference to Piaget's core concepts of assimilation and accommodation. Assimilators are seen as more rule bound in problem solving behavior, and as having a disposition toward interpreting new events in terms of existing knowledge. In an expansion of Piaget's concepts Explorers are seen as having a disposition toward novelty seeking, which manifests itself in a search for new types of solutions and new ways of solving problems without a requirement of external pressure to do so.

This stylistic distinction has been found to be uncorrelated with general intelligence while they correlate quite strongly with a motivational factor, and also with all the factors in the five-factor model of personality, in particular with Openness to experience. Significant differences have been found in mean scores for students in different types of educational settings, with art students having the highest scores (more explorative). A significant correlation also was found between the A-E styles and scores on a creative activities' checklist (Explorers having higher creativity scores), but there was only a weak, yet still significant, correlation with measures of verbal and figural fluency. Finally, it has been found that inventors with registered patents had a more explorative style than a relevant comparison group. Taken together, the correspondence between the A-E theory and the pattern of empirical findings is consistent with the requirements in basic definitions of cognitive style and shows an advantage for Explorers in creativity.

However, other studies have sought to validate core premises of the A-E theory more specifically. It has been found that Assimilators need task-relevant experience to use their preferred mode of processing efficiently on creativity tasks, while Explorers are more proficient when exploring the task environment when they have low levels of experience (which by implication means high novelty). It has also been found that Explorers and Assimilators performed differently based on instructions to utilize different types of problem-solving strategies on creative problem-solving tasks. This finding was interpreted as experimental evidence for the idea that people with different stylistic dispositions normally utilize qualitatively different problem-solving strategies where the experimental instructions may have compensated for task specific challenges associated with the poles of A-E styles.

Based on findings like these it has been argued that A-E styles can be seen as a relevant indicator of task-specific competence. However, such task-specific competence does not necessarily lead to superior performance. Other conditions contribute to impairing or facilitating performance beyond the degree of compatibility between stylistic dispositions and task demands. In this regard interactive effects between stylistic disposition, degree of task-relevant experience, cues in the situation such as solution hints, the salience of motivation arousing conditions, as well as positive mood, *together* may influence performance. This dynamic interplay may be explained by a theory of optimal motivation for the task, where task characteristics, styles, affect arousing conditions, and achievement motives together determine the quality of performance. Such complexity indicates the difficulty of research in this area. Yet, Explorers may be expected to perform better on complex and novel tasks, but this tendency declines when motivation or positive mood is in the higher range. On the other hand, Assimilators tend to perform better when tasks are complex but more structured, but this tendency goes down when motivation is in the higher range.

Based on this, it can be argued that the A-E styles has its main effects on creativity mainly in interaction with other influences. The theory has the advantage that it can be coherently integrated with theories of personality and achievement motivation, and recent theories of information processing. In such theories creative problem solving is conceptualized as search in large problem spaces, and/or as diverted search in an incorrect problem space. The perceived task structure is determined by the availability of solution constraints and adequate cognitive strategies in dealing with such constraints. It has been posited that the A-E styles describe individual differences in preferences for such heuristics. Thus, research on the A-E styles may shed new light on the relationship between motivation and creative problem solving, individual differences and expertise in problem-solving, as well as the relationship between positive mood and creative problem solving. Consequently, this theory may have fruitful implications in several areas of research extending beyond the domain of creative problem-solving.

Thinking Styles

In 1988 Robert Sternberg based his style theory on a governmental metaphor which rests on an assumption that people govern themselves in a way similar to societies. Thus, thinking styles are described as different aspects of self-government and include functions, forms, levels, scopes, and leanings. The three major *functions* are the *legislative (creative)*, *executive (implementive)*, and *judicial (evaluative)* styles. Four major *forms* of government are the *monarchic* (preference for one goal at a time), *hierarchic* (preference for multiple goals ordered in a hierarchy), *oligarchic* (preference for multiple goals, where each is equally important), and *anarchic* (avoids rules and systems). Two basic *levels* of government are the *global* (preference for general problems demanding abstract thought) and the *local* (preference for tasks that require detail and precision). Two domains in the *scope* of government are the *internal* (preference for tasks that allows people to work alone) and the *external* (preference for tasks that allow working together with others). Two core *leanings* are the *conservative* (preference for the familiar and traditional) and the *liberal* (preference for going beyond existing rules and regulations).

Sternberg's theory shares basic similarities with other theories of cognitive styles: styles are placed at the interface between personality and cognition, express the manner of cognition, and should be uncorrelated with intellectual capacity. However, thinking styles can still be related to more local domains of capacities.

Sternberg's theory, like Kaufmann's, has been developed within a theory of intellectual functioning, which may simplify both the operationalization and the evaluation of the stylistic dispositions compared with other style theories. Still, cognitive styles have typically been defined as bipolar constructs, while thinking styles are defined as unipolar constructs that together create a stylistic profile. The bipolarity assumption that is common in most theories of cognitive styles is thus rejected in the theory of thinking styles, although this may be an empirical question.

Sternberg included styles in his theory of creativity and found negative relationships between creativity and the executive, conservative, and monarchic styles. A combined score on these styles was significantly and negatively correlated with an overall measure of creativity. Contrary to theoretical expectations, the legislative style was not correlated with the measures of creativity. However, other studies have shown that giftedness was associated with Type 1 style and that creative writers also scored higher on the same type of style. Also, recent studies have emphasized that Type 1 style is the better predictor of creativity, including creativity-promoting teacher behavior. Taken together, a growing number of studies have strengthened the validity of the theory of thinking styles and its relation to creativity.

In more recent conceptualizations of the theory, three superordinate dimensions of styles have been described, with different aspects of thinking styles included within each. The first of these, labeled '*Type 1 style*,' includes the legislative, judicial, global, and hierarchical facets. The second, labeled '*Type 2 style*,' includes the executive, local, monarchic, and conservative facets. The third style, labeled '*Type 3 style*,' includes the oligarchic, anarchic, internal, and external facets. A number of studies have shown that the Type 1 style is associated with openness to experience and conscientiousness in the five-factor model of personality, higher adaptiveness, higher self-esteem, enhancement of positive emotions, the motive to approach success, better mental health, and more. Type 2 style has been associated with neuroticism, the motive to avoid failure, and other typically conceived, negative influences, while tendencies to have higher academic achievements were also evident in association with this style. Further studies have focused on educational issues. The theory has moved away from a position where all styles have equal value. Zhang suggest that the three types of styles may serve as an organizing framework for style theories in general.

Alternative Theories

Some of the more recent theories of styles have, in various ways, been related to the process of creative problem solving. One such theory has been developed by Min Basadur. This theory maintains that there are two main stylistic dimensions, one describing two different ways of *acquiring* knowledge, and the other relating to two different ways of *using* knowledge. The two different ways of getting knowledge are through experiencing and ideation, and the two different ways of using knowledge are through thinking and evaluation. Various combinations of these stylistic attributes yield different typological interpretations, and these are labeled *Generator*, *Conceptualizer*, *Optimizer*, and *Implementor*. This measure seems to be based on a measurement technique that has some limitations while the constructs themselves seem to echo the idea of problem finding versus problem solving, which is also related to creative producing and creative solving of problems and ideas. Recent research has sought to improve the instrument as regards reliability and other measurement qualities.

A second theory in this category has its roots in the brainstorming-oriented theory developed by Alex Osborn and Sydney Parnes and is promoted by Gerard J. Puccio who maintained that there are four different individual preferences related to the process of creative problem solving. These four preferences were labeled *Clarifier*, *Ideator*, *Developer*, and *Implementer*. The Clarifier preference describes aspects of data finding and problem finding in the Creative Problem-Solving framework. The Ideator preference describes aspects of mess finding and idea finding. The Developer preference describes aspects of solution finding and the planning aspects of acceptance finding. The Implementer preference describes action-oriented aspects of acceptance finding. The theory and its measure have been developed in stages, and currently factor analyses and correlational analyses with other popular and creativity relevant measures have been undertaken. Correlations with the Adaptor-Innovator dimension and the five-factor model of personality have been identified. However, it awaits further and more rigorous analysis.

A third theory has been called VIEW and assesses creative problem solving style. It has been developed by Edwin C. Selby, Donald J. Treffinger, Scott G. Isaksen, Kenneth J. Lauer, and others as a novel integration of constructs, while it also seems to be operationalized in a way that is close to some existing style and type constructs. Its main focus is individual differences in relevant aspects of creative problem solving, and it measures three styles. The first style is labeled *Orientation to Change* and describes a distinction between *Explorers* and *Developers*. The second style is labeled *Manner of Processing* and describes a distinction between *External* and *Internal* ways of processing. Finally, the third style is labeled *Ways of Deciding* and describes a distinction between a *People* and a *Task* orientation. The items in this inventory represent what may be conceived of as semantic differentials which may represent preferences between true opposites or contrasted constructs. Factor analyses has supported the conceptual three factor distinction in some studies, but not all, and a number of correlations with type, trait, and other style measures support the theory's validity. Lack of correlations between this measure and measures of creative abilities have been taken to support a distinction between style and level of creative ability. Other studies support other aspects of construct validity, and results from a recent quasi-experimental study indicates that style-based training and coaching over a nine-week interval may increase participants' creativity. Some design limitations may still caution against this interpretation.

A fourth theory has had the aim to integrate creativity relevant constructs from previous style-, motivation- and trait-research on creativity. In this approach Øyvind L. Martinsen developed the Creative Person Profile (CPP) which included 7 broad factors that were based on 27 more specific, creativity relevant constructs. Among these, *Associative orientation* (fantasy, absorption, playfulness etc) and *Flexibility* (adaptability, restructuring etc) were seen as cognitively oriented constructs aimed at ideation, fantasy, and restructuring. *Ambition* (need for power, need for recognition, need for attention etc), *Motivation* (need for achievement, autonomy, novelty seeking etc), *Need for originality* (preference for rules (R), opposition against conventions, rigidity (R) etc) were motivational and attitudinal. *Agreeableness* (Concern for others, Friendliness and Critical attitude) were seen as interpersonal but also as describing problem finding through being critical and less concerned with interpersonal considerations. *Emotional instability* (mood swings, neuroticism, low confidence etc) described tendencies towards negative emotionality. Five of these constructs overlapped with the five-factor model of personality, while all seven factors were at best weakly related to intelligence. Among the seven dimensions some were found to be associated with performance on creativity measures like ideational fluency, creative problem-solving tasks and a remote associate test, and also with accomplishments in diverse creative activities. Other constructs were related to differences between groups like artists, who are generally held to be creative on the factors, and a group with other types of backgrounds. However, few studies have been done based on this theory hitherto.

Discussion and Future Directions

There are important limitations of the research in this area. The *first* concerns the validity of cognitive style constructs, the *second* concerns the design of studies on cognitive styles and creativity, and the *third* concerns the perspectives on style-creativity research.

First, further research is still necessary to settle more definitively whether several cognitive style constructs represent *autonomous* constructs, or whether they eventually boil down to a mix of stylistic expressions of ability and personality constructs. Several style constructs stand in need of sharper examination on the merits of their *incremental validity* against ability and personality factors. That is, does one advance or handicap the field by mixing personality and ability/preference and power/concepts into style? The jury is still out on this issue.

One interesting path for future style research can be inspired by research on compound traits, or emergent traits, which has a long history in research on personality. Such traits, like integrity, emotional intelligence, managerial potential and more, are typically measured by criterion referenced tests that purport to measure specific behaviors in applied settings. Common for several such traits is that they are factorially complex and typically related to Neuroticism, Agreeableness, and Conscientiousness. Thus, styles may be seen as describing specific, cognitive phenomena that mediate profiles of personality traits and/or abilities. Consequently, to the extent that style theories can be placed in a conceptual space with personality and ability constructs and shown to have some kind of legitimacy beyond the traits that they originate from, it would further validate style as a useful construct in psychology. A clarification of such ideas would also explain further the factorial complexity typically observed for some style measures and the multiple personality correlates for the same measures. In this regard, styles could be classified as Intellectually focused Personality Scales (IPS) with similar potential and limitations as the compound traits previously mentioned, or Criterion focused Occupational Scales (COPS). These ideas have been elaborated by Adrian Furnham and others.

Second, the research designs most frequently applied in stylistic research on creativity still seem to be non-experimental. This limits our understanding of the results and the possibilities of making causal inferences about style-creativity relationships. If

we are to investigate the possibility that cognitive styles, for example, describe different ways of being creative, it is indeed necessary to apply aptitude–treatment interaction studies to shed light on such issues. In research designs like these, individual differences in cognitive styles are combined with experimental manipulations of task contents, work conditions, or other situation conditions, with the inclusion of necessary controls for alternative interpretations in terms of abilities and personality factors. Unfortunately, such more powerful research designs have been scarce during the history of style research.

Third, it seems necessary to investigate further the relationship between cognitive styles and creativity based on different conceptions and measures of creativity. Presently we have at least four different perspectives on creativity that are important for stylistic research. The *first* one of these perspectives is a micro or ipsative perspective, where an individual's creativity is based on a comparison between the degree of novelty in a product or idea and that in the same person's previous products or ideas. This is an individual perspective where everyone can be seen as creative only in the sense of increasing their creativity. A *second* perspective is a macro or normative perspective, where a person's creativity is compared with other persons' creativity from an objective perspective. This is the invention or innovation perspective, where only a few people are creative – this is the idea of the normal distribution. The *third* perspective is a component perspective, which can be integrated with either of the two preceding micro and macro perspectives. Here, the stylistic influence on various subcomponents of creativity (like insight, analogical reasoning, remote associations, ideational productivity, convergent thinking, etc.) can be studied. The *fourth* and final perspective is the domain specificity of creativity; i.e., if some styles predict creativity in certain domains but not in others? Style researchers need to be more aware of the several conceptual and operational distinctions that can be made in creativity research, and to adjust their research designs accordingly. Thus, the criteria and designs in style–creativity research must be specified based on *a priori* theoretical and/or operational definitions of creativity or creativity relevant processes.

Based on this overview of current research on individual differences in cognitive styles, the hypothesis that cognitive styles do indeed have a function in creativity seems reasonable. Still, the present theories need to be developed further in order to yield more precise information on the relations between style and creativity. Meeting this requirement also depends on further progress in creativity research where the criterion problem is multifaceted and difficult to solve.

The evidence is not clear enough for a reviewer of the relationship between the style and creativity literature to despair or rejoice. The pessimist would point to the endless models, measures and theories of cognitive/learning/thinking styles, none with very impressive evidence of psychometric validity, particularly convergent, divergent, construct, and predictive validity. They would also point to the creativity literature which remains for differential psychologists something of a backwater, with little real development in terms of measurement. In other words, this is the relationship between two conceptually unclear and methodologically weak fields. The optimist on the other hand, may point to a lively applied and cross-disciplinary rather than moribund field using more sophisticated methods of research to investigate the intriguing issue of creativity. Both are very big areas and it may be that the field will best advance by concentrating on a highly specific area. Thus, if we have problem finding versus problem solving and arts versus science (divergent vs. convergent) problems, it is possible we could find the cognitive style associated with divergent problem-finding more convincingly. The importance of this level of analysis has been recognized.

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- foursightonline.com/home-page.html. <https://foursightonline.com> – (Innovation Tools for Thinking Teams).
- kaicentre.com/. <http://www.kaicentre.com/> – Occupational Research Center & KAI Distribution Center.

Collaboration

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To collaborate is to work jointly with one or more to the same end. There are multiple examples of famous creative collaborators in popular culture across various domains from music (e.g., Paul McCartney and John Lennon), art (e.g., Frida Kahlo and Diego Rivera), scientific innovation (e.g., Marie and Pierre Curie), opera (e.g., Gilbert and Sullivan) or even magic (e.g., Penn and Teller). Creative collaboration also occurs in groups from large scale movements such as the Romantics or Pre-Raphaelites who collaborated across different artistic domains to smaller groups such as members of a jazz ensemble or improvisational theater troupe. In all cases, group members are commonly accepted to have intimate involvement in the emergent creative works and oftentimes, the creativity is necessarily dependent on the involvement of others (Sawyer, 2004). These collaborations are often seen as tempestuous but are also productive and arise from a close intimacy maintained over an extended period of time.

This entry starts by assessing the differences between group creativity and collaboration. We then move to make a distinction between direct collaboration, which is clear and explicit, and more indirect forms of collaboration where the collaborative traces of other unnamed partners (whether human or not) can still be clearly observed. Finally, there is a look at the challenges ahead for those who research this unique and complex phenomenon and also the implications of adopting a collaborative perspective on creativity as a whole.

The Importance of a Collaborative Perspective on Creativity

Current research on creativity shows a tendency to focus on the attributes of the creative individual or casts the individual's internal thought processes as the causal factors that produce creative cognition. That this viewpoint is more prevalent in creative cognition research than creativity research in management which is more applied and has more of a focus on team cognition indicates its limited scope. This research focus necessarily privileges both the individual as a unit of analysis and a methodology which casts creativity as an additive and generally linear process. Such an epistemological position pins the locus of creativity on the individual and casts group creativity as something that occurs when a measurable outcome is formed by the interaction of these individual creative units (Glăveanu, 2011).

However, such a research program, while elucidating some aspects of the creative process, does not reflect collaboration as documented across other naturally occurring domains. Those who study collaborative creativity as distinct from group creativity assert that some creative processes and products cannot be fully understood at the individual level of analysis and that group level analysis is necessary (Glăveanu, 2011; Sawyer, 2004). This is true whether those groups are defined formally and recognized as a contained ensemble of participants (e.g., a football team) or less formally as a fluid ensemble of direct and indirect collaborators. Research into collaborative creativity approaches creativity as an in-between process with a final creative product that emerges from the combination and interaction of different, human (and even non-human) participants yielding a complex process which cannot be reduced to individual units of analysis.

The Distinction Between Group Creativity and Collaboration

There is not a consistent distinction between group and collaborative creativity in the research literature and although different researchers have pushed to make it clearer, the two terms are often used interchangeably. Traditional laboratory studies investigating how people create together (e.g., research on brainstorming; [Oxley et al., 1996](#)) have come to the often-surprising conclusion that working in groups reduces creative output whether that is assessed as the number of creative thoughts or the quality of those thoughts.

However, it is not clear that the conclusions of assessments of group creativity reflect creative collaboration and certainly not collaboration as it more commonly found outside of an experimental setting ([Montuori and Purser, 1997](#)). Such naturally arising and often self-selecting collaborations are qualitatively different to experiments of group creativity conducted in a lab. Lab based studies assess how a creative product, which could potentially be produced by an individual, changes when produced by more than one person. This position assumes that the other people in the process are simply another input into the input—process—output schema of individual cognition.

As such, this research focuses on such things as process gains and losses when assessing group performance against the benchmark of individual performance reflecting a belief that there is a measurable outcome which could be achieved by an individual as much as by a group. A process gain is when a group working together outperforms the expected performance of someone working alone, a loss the inverse. Often, actual groups are pitted against nominal groups to create this benchmark. A nominal group in this instance is typically made up of the scores of matched individuals who have experienced the same task alone and whose scores are artificially tallied to produce a 'group' score. This artificial situation does not reflect collaborative creativity as understood in the wider literature.

The focus of this entry will be on collaboration that involves a creative product that could not be produced by a single individual and, in this context, relative process losses and gains become less important. [Moran and John-Steiner \(2004, p. 11\)](#) referred to collaboration as “an intricate blending of skills, temperaments, efforts and sometimes personalities to realize a shared vision of something new and useful.” Regarding collaboration as a naturally occurring relationship between two or more people often leads to changes in methodology with a focus on a qualitative, idiographic approach exploring how non-substitutable components interact. These components will almost certainly have different qualities to each other and thus products of collaboration as a complex system are best considered as truly emergent—that is irreducible to their constituent parts ([Sawyer, 2004](#)). In order to capture such creative phenomenon, it behooves us to extend the level of analysis beyond individual processes in a group environment to group processes.

Methodological Implications

As in all areas of psychology, the epistemological stance taken on the nature of collaboration in creativity drives the methodology used to understand it. Traditional quantitative outcome measures that aggregate means across people are ill equipped to capture the unique nature of collaboration as theorized above so researchers who study complex creative systems such as a jazz ensemble often employ idiographic and qualitative method to disentangle the contingent dynamics of collaborations. The more common methods used are:

1. **Video data.** Video data can be used in both natural settings ([Sawyer, 2004](#); [Seddon, 2004](#)) and more artificial lab-based settings ([Bjorndhal et al., 2015](#)). These rich data sets allow the detailed analysis of actions, discourse and interaction with the surrounding environment. While at times traditional creativity tasks are used, the use of video data allows for a more detailed analysis of the process in real life tasks and an easier identification of communicative exchanges.
2. **Interviews.** Alongside traditional interviews, John-Steiner introduced the collaboration Q sort which invited collaborators to discuss where to place 50 statements on collaboration and then showed the resultant array to their collaborator (John-Steiner, 2006). The discussion of differences and similarities is meant to spark a retrospective account of the collaboration and foster reflexivity.
3. **Biographies.** Much work on eminent creative minds has proceeded from letters, diaries and biographical details of the individual and work on creative dyads is no different when it comes to using this rich biographical detail to make inferences about the creative processes involved when two or more people work together.
4. **Conversation Analysis.** Alongside video analysis, a detailed look at how collaborators synchronize their utterances can be a good measure of integration and alignment in the creative process. This kind of analysis reveals both the content of communication and, more importantly, communicative patterns among collaborators.

Direct Collaboration

In many cases, collaborations are clearly defined and acknowledged cases of creative partnerships consisting of more than one named contributor to a final creative work. We characterize these as direct collaborations where collaboration is seen as two or

more people intentionally working toward the same goal. These collaborations are formed from intentional partnerships arising from an intimate relationship built up over time.

Measuring Collaboration in the Lab

It is not impossible to measure true collaboration in the lab, but it requires a different approach and the understanding that working together does not necessarily indicate working *collaboratively*. In a series of papers, Johanne Philipsen explored how people working in groups produced and developed new ideas as they worked with LEGO bricks. She video recorded teams of 3–4 participants as they built LEGO models of concepts such as “justice” and “collaboration”. Clearly, such concepts don’t directly correspond to a particular configuration of LEGO blocks and accessories, hence the exercise results in contingently singular constructions determined by group dynamics. Philipsen and her collaborators used this video corpus to mine for interaction styles—inclusive, instructional, integrative—among team members and their resulting material traces, as revealed by the LEGO models produced (Bjorndhal et al., 2015).

The inclusive style of interaction is characterized by positive feedback and praise: everyone’s idea is validated and results in an uncritical quilt-like medley of ideas, “a concatenation of individual ideas” as the authors put it. The ownership of the resulting model was distributed although the final model didn’t quite work. Participants appeared more focused on smoothing interactions with strangers and ideas were not critically elaborated. The lack of familiarity among members of the team appears to be a key factor since the authors reported that this form of interaction was more likely to occur early in the test session.

The second style of interaction, the instructional style, resulted in conceptual ownership that was less distributed since one member of the team guided the construction of the model. The leader or instructor elaborated her ideas, a process validated but not challenged by other team members. As a result, the final model was more coherent, reflecting the creative arc governed by a single constructor but the group potential was not leveraged to its full extent.

Finally, in groups with an integrative style of interaction, ideas were challenged and elaborated continuously through interruptions, amplifications, and negative feedback. Ideas were not unconditionally validated but rather connected and synthesized through a distribution of cognitive labor. The material trace of an integrative style, that is the final LEGO model, was more coherent and reflected a more distributed creative process. In the instance described in the paper, the model embodied complex ideas such as the dynamics and outcomes of the presence or absence of “collaboration”. The integrative style was more likely to occur later in the problem-solving session when team members were more familiar with each other.

Close Collaborative Pairs

The integral role of familiarity when eliciting true collaboration in laboratory experiments is amplified in ‘real world’ collaborations. In these, a singular creative product is generated alongside an ongoing social relationship. These close intimate relationships—be they familial, marital, or based in friendship—can lay fertile foundations for creativity in the arts and science. The long and shared history of interests, conversations, and joint experiences forges the trust required to think freely but also to accept and seek a partner’s criticisms and alternatives; these elements can structure a productive and creative working relationship.

Innovative and celebrated sibling filmmakers include Auguste and Louis Lumière, Ethan and Joel Cohen, and Lana and Lilly Wachowski. The Wachowskis make multi layered, multi part, science fiction movies that challenge the orthodox movie narrative and which, in turn, require multiple viewings to appreciate their depth, texture and detail. They tackle issues of reality and identity, change and revolutions and the grotesque dystopian projection of corporate dominance over people and culture. The Wachowskis’ creative collaboration extend beyond writing and directing, resulting in innovative techniques of cinematography (including the bullet time method to spectacular effects in *The Matrix*) and editing (in *Speed Racer*).

Hemon (2012) described how the Wachowskis adapted David Mitchell’s (2004) “unfilmable” novel *Cloud Atlas*, the movie Lana Wachowski says she’s most proud of (Keegan, 2018). Mitchell’s novel involves a large cast of characters in six different stories spanning five centuries. Hemon (2012) depicted how the Wachowskis along with their close collaborator, Tom Tykwer, rented a beach house in Costa Rica where over weeks they segmented the novel into hundreds of scenes, sketched on colored cards, with colors corresponding to characters and time periods. These external representations were then physically manipulated, moved and re-arranged throughout a working day to determine which narrative arc worked best. This process was repeated the next day. It is through this form of distributed cognition—across three collaborators, across objects and their spatial arrangements, across time—that the film’s innovative narrative structure emerged as well as the idea of using the same cast of actors, embodying different characters, across the centuries, capturing the novel’s central idea, namely eternal recurrence.

Such an intimate collaborative relationship produces creative pieces that are irreducible to the internal cognitive processes of the individuals. Rather, they can only be understood as arising from a unique and contingent collaborative process. Moreover, in the case of long-term artistic collaborations like the Wachowskis’, such works can only be understood when situated in a timeline in which the creative and personal are not only indistinguishable, but their very entanglement is an essential element of that creativity.

Artistic Collaboration in Groups

Some forms of artistic creativity are explicitly collaborative and necessarily relational; these cannot be carried out by a single individual, however talented. Group jazz improvisation is one such art form which simply cannot be understood in terms of individual,

conscious cognitive processes. This form of group creativity is so explicitly collaborative that Seddon (2004) suggested it generates an “empathetic creativity”, that is, a creativity that is ontologically dependent on the presence of others. Indeed, such groups are a fundamental challenge to a reductionist notion of creativity, not only because an analysis of the individual’s creative output would not capture the final product in a satisfactory manner, but also because it is impossible for the individuals in the group to know, let alone shape the creative process. In improvisational performance the social group is not only conceived of as an abstract influence, but it is present at each moment of the creative act and the resultant piece is explicitly interactional. When assessing the creativity of such a group, one can’t just look at the product because it is necessarily ephemeral, so the listener must take into account the process, and the practice of music making; the “creative process and the resulting product are co-occurring” (Sawyer, 1992, p. 253).

Furthermore, band members cannot be simply exchanged for other equally talented members because music making in such ensembles is a dynamic and shifting mix of formal and informal approaches. As is the case with the types of close creative collaborations outlined above, creative processes in this environment are informed by social processes as much as the act of creativity itself (Kenny, 2014). Importantly, satisfactory improvisation in such groups does not happen spontaneously but rather arises from social interactions that act as backdrop to supply the level of trust necessary to work collaboratively (Kenny, 2014; Seddon, 2004). The creativity is enacted in the moment, but the collaborative ties are formed over time. In her ethnographic study of creative collaboration in a jazz ensemble, Kenny wrote of a “sense of camaraderie” (p. 4) and a “shared history” (p. 5) and Seddon told of two members of the band he studied who had attained a higher level of “sympathetic attunement” (p. 73) through spending time playing and traveling together. The piece of music then emerges from this mix of current work and shared history and cannot be understood simply as the addition of talents from interchangeable components in an easily generalizable model.

It is clear that a full understanding of at least some domains of artistic creativity requires understanding the complex dynamics of collaboration between people because the collective nature of the performers is an essential part of the creative process and product. In improvisational performance art, these dynamics are particularly important because the ephemeral nature of the product places the emphasis on the process and, in fact, collapses the distinction between the two.

Collaboration in Scientific Creativity

Scientific creativity is more commonly thought of as innovation, but it requires a level of creativity that is similar to the arts—the creation of something novel and valuable. Indeed, the parameters of novelty and value may be rather easier to establish in scientific creativity. Scientific collaboration is not a new phenomenon—the first co-authored paper appeared in 1665. There has, however, been a significant increase in scientific collaborations with ambitious projects such as the Large Hadron Collider pooling resources in order to further scientific discovery and creativity in way that a single team cannot afford to do. Co-authorship of scientific papers has been rising steadily both in terms of the numbers of authors and the number of countries from which those authors are drawn. This rise in collaboration is shaped by the increased ease of international communication alongside the need to share more advanced and expensive technological resources.

Increased collaboration has a positive impact on productivity and the citation level of individual researchers, but it also has a wider impact; it effectively increases the range of what is possible in scientific research. Beyond the pooling of financial resources, scientific collaboration allows creativity to develop in a non-linear, iterative and reciprocal manner. The benefits of scientific collaboration are not just realized by a brute force increase in numbers but also by encouraging and exploiting disciplinary diversity. As seen above, what emerges is more than a linear, additive formula treating collaborators as interchangeable units. This transdisciplinarity is essential to capitalize on serendipitous discoveries.

As collaboration occurs across disciplines, it encourages diverse groups of researchers to pool different areas of expertise to create something that would not be possible for one individual. This, in turn, allows individuals to become increasingly specialized within a team of other specialized individuals which they would not be able to do without offloading some skills to others. This creates an iterative relationship between the individual and the group extending beyond an analysis of the scientist as an individual. Moreover, such relationships are marked by a similar level of trust as the more standard artistic collaborations. The complexity of modern scientific collaboration supports a specialist rather than a polymath so it requires relinquishing individual control and therefore cannot be analyzed at a purely individual level.

Indirect Collaboration

Beyond the direct and documented collaborations outlined above, there is a growing research field which extends the understanding of collaboration to encompass objects, people and ideas which do not collaborate in a formal way, but which nonetheless shape and are agentic in the final creative process or product.

Cultural Collaboration: Sociocultural Serendipity

Not all collaboration is planned, direct and documented; some collaborations remain undocumented or even unnoticed but leave clear traces on creative output that is indistinguishable from the more direct collaboration outlined before. The phenomenon of multiple discovery when a scientific invention occurs simultaneously in different parts of the world, cannot be explained without reference to the social nature of creativity (Simonton, 2019). Beyond these moments of unrelated, simultaneous

innovations, certain “golden ages”, elucidated by historiometric analysis, support an essential role for the socio-cultural milieu. These particularly fertile moments in the history of innovation and creativity suggest that indirect collaboration is essential to the rise of eminent creative geniuses. Renaissance Florence is one such time period for artistic creativity as is the golden age of scientific creativity in the Islamic civilization (Simonton, 2019). These golden ages, with a concentration of eminent creative individuals, underscore the importance of non-intentional, spontaneous collaboration which may often be unacknowledged even by those involved.

Even those people characterized in the collective imagination as an individual genius who transcends those around them are perhaps best understood as arising from a complex network of indirect collaborations and socio-cultural forces. Take, for example, the work of Shakespeare: The modern desire to attribute authorship to one sole individual and grant him ownership of the text is anachronistic when applied to his plays which were generated when ideas of text ownership were not understood as they are today. It is notable that the entire field of authorship studies has now arisen to disentangle the phraseology and words that can be attributed to different single authors from this period. Thus, collaborations are woven into the very fabric of the texts society has inherited and these texts reflect speech patterns and thoughts that cannot be easily attributed to any one person. For example, Marlowe’s and Shakespeare’s influence on each other until the former’s dramatic death was substantive to the extent that there are still many who are convinced that Marlowe is a better candidate for authorship of the plays commonly attributed to Shakespeare.

An analysis of the role of collaboration in creativity is incomplete without taking into account that the creative process happens in a particular sociocultural field which structures, constrains and extends possibilities beyond the potential of conscious and intentional collaborations explored in the previous section. There are fertile moments in history that generate cultural moments from which new creative products emerge. We would term this sociocultural serendipity. Serendipity describes a process beyond chance, characterizing moments in which both luck and the individual are necessary but not sufficient in themselves. Rather, serendipity is a relational term and generates a framework to understand how creativity can be reliant on both the exceptional talents of an individual and the unique characteristics of a certain time period without privileging either. This sociocultural serendipity reflects a non-intentional but nonetheless vital collaboration between the individual and the sociocultural background.

The Audience

The role of the audience is pivotal to all creativity. Performance art is particularly heavily and necessarily reliant on audience participation; anything which occurs in the absence of an audience is not considered a creative act, it is a rehearsal. In compositional performance art, the final creative product is nominally created by the playwright, performer or choreographer but interpreted by the actors and, crucially, the audience. To return to the example of the jazz musicians, the interaction with the audience is typically considered a key element of the interactional context (Sawyer, 1992). Furthermore, in some cases, the audience is an active participant in the piece of art as it unfolds, even if not at the compositional stage.

Take, for example, Maria Abramović’s 2010 MOMA piece of performance art “The artist is present.” In this piece of work, Abramović was seated silently at a table while members of the public came to sit opposite her. While explicitly centered on Abramović and her presence, this performance was also necessarily interactional—the art and the audience became one. Indeed, one of the many creative outcomes of the piece was represented by the emotions provoked in the audience. The creative product shifted with each new visitor and generated an ephemeral process much like the improvisational jazz outlined above. While the initial creative idea arose in the artist (albeit not a socially isolated artist), the process of enacting that idea was necessarily collaborative and interactive. More recently, *Black Mirror*, Netflix’s television serial released an episode (*Bandersnatch*, David Slade [Director], Charlie Brooker [writer]) in which the audience can be actively involved and choose their own ending. Thus, while the writers and actors created the episode, the final form is a unique collaboration of their creativity and the choices of the audience. Indeed, with digital technologies making it easier to invite audience participation, this sort of asynchronous collaboration may be more common in the near future.

The same is true of art forms in which the audience is more commonly considered passive, such as the novel. For a fictional novel to function as a creative form, the readers are required to engage their imagination and to recreate the fictional world of the author. An unread book remains inert until it is recreated in the mind of the reader in the same way as a play is in a constant state of rehearsal until the moment it is staged in front of an audience. The reader has an essential role to play by taking the fiction beyond the control of the writer. This is clearly demonstrated by the intense disappointment some readers feel when there is a mismatch between a cinematic representation of characters and the character that exists in their imagination. The result emerges from the filling in of the spaces left by the writer and so is contingent on collaboration with the reader.

Material Collaboration

The creative product is often constrained by the things around it across all domains. It is a commonly reported phenomenon that the materials used in artistic creativity influence the creative act and shape and constrain what can be done.

Take, for example, the experience of working with clay. Paul March’s (2019) writings on this process reveal how the actual physical materials with which he works shapes the creative process with the delicate nature of porcelain contrasting with the more robust nature of stoneware:

The physicality of sculptural experience can be felt by comparing two different clays: stoneware and porcelain. Metaphorically speaking, stoneware is dynamic, generous and forgiving—confident in its plastic potential. Porcelain is intransigent and full of inertia. With porcelain, the act of creation and the outcome of the engagement with my hands take place within boundaries set by the clay's limited elasticity and excessive friability. Sculpting with porcelain is a tense negotiation (March, 2019, p.137).

The subtly different affordances of the material used constrain and shape the final artistic work with a similar level of influence to a human collaborator: that is, they are a causal factor in some aspects. Moreover, there is a relationship of trust and tension which mimics the intensity of the human/human relationships described above. Other artists discuss being aware of how material reacts and how they respond to a question posed by the material rather than imposing their imagination on that object (Botella et al., 2013). Creativity implies production, co-creation. Just as performance art is contingent on the collaboration with the human audience for its very existence, artistic creativity is equally contingent on materials.

Conclusions

Our understanding of collaboration in creativity takes us away from laboratory analyses of creative cognition happening in groups but being analyzed at the individual level, using measures and methodologies more suited for individual creativity. The focus on collaboration proposed here is not without its own challenges. To begin with, it is intrinsically difficult to study dynamic, developmental phenomena such as unfolding conversations and the trajectory of ideas in spaces of co-creation than measure personal traits or properties of objects. Second, the emergent nature of collaborative encounters makes it almost impossible to predict beforehand what will be produced and how. Finally, the creativity of collaborative pairs and groups is expressed at multiple levels, from the concrete outcomes they generate to the social consequences they usually have (e.g., creating group identities, fostering efficacy at a group level, promoting prosocial mindsets).

In the end, there is a tendency to reduce creativity (as is the case with many psychological phenomena) to the intentional acts of an individual which are then traced back to her internal processes, personal history or character traits. However, as argued here, creativity itself simply can't be explained fully using this level of analysis because creative processes emerge from the collaboration, explicit or implicit, of both intentional and unintentional creative agents. Even the most seemingly individual acts of creativity build on objects created through division of labor in society and ideas co-created with others, including cultural tools that are the outcomes of entire societies across time; creativity is temporally as well as socially situated. Collaborations often follow unique trajectories and their creative products emerge from the dynamic interplay of various factors that can only be interpreted in systemic and interactive terms.

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Commoditizing Creativity

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Introduction

For much of history, and certainly since the time of Plato and Aristotle, creativity has been characterised as a *special talent*. A common explanation, at least until the Renaissance (which began in around 1300), was that *creation* is the sole concern of higher powers. Under this premise, creative humans must therefore be acting under the direction of those powers. Plato spoke of a creative *divine frenzy*, while Aristotle referred to a *tincture of madness* colouring the creative individual. According to this view, creative people behave the way they do because they are compelled to carry out the wishes of the gods, whether they want to or not: it has been suggested that this view is possibly pre-historic, and may have prevailed even at the time of the cave artists.

The divine-inspiration explanation of the origins of creativity persisted through the Renaissance, although with an important change: the source of creativity was thought to lie *within* individual creators in the form of a special “genius” which they possess but others do not. According to Kant (1914 [1790]), this genius is an “*innate mental predisposition*” (p. 188, emphasis added): A few people possess it as a gift from nature, but most do not. Creativity therefore remained linked with the idea of *otherness*, or even madness.

Even in modern times, creativity has struggled to break this association with exclusivity. Many of the myths and misconceptions of creativity (see, for example, Cropley and Patston, 2019) are anchored in notions that creativity is only found in the arts, or that creativity cannot be taught (precisely because it is a special talent). Many people still, as Kawenski (1991) noted, believe that creativity involves simply sitting around and “waiting for the muse to strike them” (p. 263).

Fortunately, for creativity, this view seems to be shifting rapidly in the wider population. This shift began, of course, with Guilford's (1950) modern characterisation of creativity as a vital component of human intellectual ability, and has been reinforced, for example, by studies of *malevolent* creativity which serve to break a parallel association between creativity and *goodness*.

However, it is perhaps the very recent discussions of 21st century skills, and the *future of work*, driven by the rapid onset of the Fourth Industrial Revolution, that are leading to discussions of creativity as something more than just a special talent, or a gift from the gods. Creativity, in this 21st century setting, has become something – a *skill* – that is useful and valuable. For example, the World Economic Forum's *Future of Jobs Report* (Leopold et al., 2018) emphasises the importance of creativity as a means to increasing innovation and ideation in the future of work. Creativity is a form of *human capital* – an economically valuable asset possessed by individuals – that can be developed, nurtured and exploited (see Walberg and Stariha, 1992, for a discussion). Sternberg and Lubart (1991) expressed this notion in their ‘investment theory’ of creativity, whereby individuals buy low and sell high; that is, they pursue innovative ideas that are currently undervalued, and then sell them before other individuals come up with the same idea.

As *routine*, and convergent, human activities are increasingly performed by machines and artificial intelligence, the ability to find new and effective solutions to problems – creativity, in other words – has become, as Bruner (1962) forecast, the *last bastion of human mental sovereignty*. Has creativity become, in effect, a *commodity*?

The History of Commodities

A commodity is a *homogenous economic good* – a raw material – that is of use and has value. Traditional commodities include, for example, grain, beef, electricity, oil, and precious metals. The idea of commodities existed even in the world's oldest civilisation; in Sumer (modern day Iraq), during the period 4500–4000 BCE, clay tokens or seashells were exchanged for goats or pigs. It was during the 1500s, in the Common Era, that the concept of a *Stock Exchange* was initiated by the Dutch, replacing earlier, and more rudimentary commodity trading *marketplaces*. Commodities trading was not limited to Western civilisations; there are records of rice trading in Japan in the 1700s.

The Chicago Board of Trade was created in 1848, with the primary commodities traded being corn, wheat, cattle, and pigs. Nearly a century later in 1934, the United States government established the *Commodity Price Index* – initially recognising only 22

commodities – as they presumed these to be the first commodities influenced by economic conditions. Even in modern times, agricultural commodities can affect economies as uncontrollable circumstances, such as droughts, impact supply and demand.

Commodities in Modern Society

With the growth and development of financial markets in the late 20th and early 21st centuries, more than 3000 commodities are now recognised. In addition to the traditional mainstays, modern commodities include communications bandwidth, emissions credits, and crypto-currencies, to name just a few examples.

Commodities are distinguished by certain key characteristics. These provide a framework that can be used to understand and explore the nature of creativity. Commodities are: (a) *standardised*, in the sense that an ounce of gold is the same, whatever its provenance, and will attract the same price. The value of a commodity is not impacted by brand; (b) they serve as *inputs in a value-adding process*. Typically, little or no value is added to the commodity itself, however the commodity leads to the creation of value-added products and services; (c) commodities exist where there is a *market* of buyers and sellers. Supply and demand dictate the market, and the price, for commodities.

Can people, in the sense of their skills, knowledge and abilities, be regarded as commodities? Is human capital, in other words, a commodity? A simple example, manual human labour, serves to illustrate. In this example, the labour performed can certainly be regarded as an input to the production of value-added goods and services. It is largely standardised, in the sense that, in most countries, unskilled labour attracts a standard wage, regardless of who performs it, and the wage is usually dictated by supply and demand. When demand is strong, and the supply of unskilled labour is short, the price may rise, and vice versa. Little value is added to the commodity itself – unskilled labour requires no qualifications that would begin to create a differentiation between labourers. Of course, there are minor differences in the individuals performing the unskilled labour, but the key is that it is treated, by the market, as uniform and standardised.

In contrast to unskilled work, skilled human labour is rather different. The addition of skills, and the development of abilities, represents the addition of value, and leads to differentiation in the basic commodity. The underpinning commodity – the unskilled individual – is no longer standardised, such that one skilled individual may command a higher price or a higher wage than another. It appears, therefore, that the addition of skills and abilities creates something that is neither traditional commodity, nor *product*. The skilled individual, through some value-adding process (i.e. training or education), is no longer standardised, and yet remains something largely contributing to the development of goods and services, rather than an end – a product – in itself. Furthermore, it is the skill itself, for example, the ability to operate a forklift, the ability to perform complex arithmetic, and indeed, the ability to generate new and effective ideas (creativity), that is the key ingredient responsible for transforming a commodity into something that, while not necessarily a product or service, is *not* a commodity! (See [Table 1](#)). Human capital, in its *unskilled* form, is a commodity. Human capital, when developed, or skilled, becomes differentiated, and this departure from standardisation precludes it from being identified as a commodity.

Creativity as Commodity?

The preceding discussion raises some questions for creativity. In particular, what is the focus of any discussion on the commoditization of creativity? If an individual with the ability to generate and exploit novel ideas – a *creative individual*, in other words – is *skilled*, then it seems necessary to conclude that this cannot be regarded as an example of *creativity as commodity* ([Table 1](#)). However, is this sufficient to rule out creativity more broadly, or in other guises, as a commodity?

It seems natural to turn to the well-known 4Ps framework to delve deeper. Creativity is commonly held to be a function of the *Person* (in the sense of personality, motivation and feelings); the *Process* (in the sense of the underpinning convergent and divergent thinking employed in creativity); the *Press*, or environment, where creativity occurs; and the *Product*, or outcome, of a creative activity.

If we consider each of these in isolation – e.g. a Person with a constellation of traits, motivation and feelings favourable to creativity – it seems immediately apparent that such an individual is more than a commodity. The very fact that these qualities, such as openness to experience, a tolerance for ambiguity, and intrinsic motivation, appear in different individuals, in different proportions,

Table 1 The characteristics of commodities

	<i>Commodity</i>	<i>Unskilled labour</i>	<i>Skilled labour</i>
Standardised?	✓	✓	×
Input?	✓	✓	✓
Valuable?	✓	✓	✓
Developed?	×	×	✓

Table 2 The 4Ps and the commoditization of creativity

	<i>Commodity</i>	<i>Person</i>	<i>Press</i>	<i>Product</i>	<i>Process</i>
Standardised?	✓	×	×	×	✓
Input?	✓	✓	✓	×	✓
Valuable?	✓	✓	✓	✓	✓
Developed?	×	✓	✓	✓	?

rules out this view of the Person as commodity. With respect to the personal qualities that favour creativity, individuals are not *standardised*.

Creativity often takes place in some sort of organisational setting. The Press (or environment) of any given organisation, like the Person, is highly differentiated. Some organisational settings are favourable to certain stages of creativity – idea generation, for example – while other settings are favourable to evaluation and validation. Like the Person, this natural variability in the environment of creativity once again leads to a lack of standardisation, and seems to rule out the creative Press as a commodity.

Is the Product view of creativity a manifestation of the commoditization of creativity? Among scholars there is widespread agreement that creativity is, at the very least, embodied in products that are both novel and effective. In other words, a creative product must be new, or original, or surprising, and, it must do what it is supposed to do. Regardless of other product criteria (for example, Cropley and Kaufman, 2012, describe elegance and genesis as additional qualities) the two *core* characteristics alone demonstrate that creativity is a property of an object, and, according to measurement theory (e.g. Cropley, 1997) admits by degrees. In other words, different products would be expected to have different levels of creativity (however this is assessed). If this is the case, then creative products cannot be commodities, because they are not standardised. If further evidence is needed, the fact that products are the result of the application of input commodities (raw materials and labour) also rules out product creativity as an aspect of the commoditization of creativity. In simple terms, commodities *lead to* products, creative or otherwise.

Is Process, then, a manifestation of creativity as commodity? Here, the situation is somewhat different from the preceding discussions. Since Guilford (1950), who spoke of ideational fluency and flexibility, and ideational novelty, a defining element of creativity has been the core process that is now widely defined as divergent thinking. The ability to generate many possible ideas from a single stimulus, in contrast to the process of searching for a single, correct answer (convergent thinking), has become almost synonymous with creativity. Both the manner in which this creative *process* is measured (for example, the Alternate Uses Test), and the criteria – fluency, flexibility, originality, and elaboration – used to assess divergent thinking (see Torrance, 1963) could be said to be highly standardised. Even broadening the discussion to a larger creative problem solving process, represented as a process of switching between convergent and divergent thinking (e.g. Guilford, 1959), results in a process that has remained remarkably stable – indeed, standardised – for over 60 years. If there is a candidate for creativity as commodity, Process may be the best fit (Table 2).

Creativity as a Complex System

One of the difficulties of any discussion of the commoditization of creativity is the underlying *systems* nature of creativity. Csikszentmihalyi (e.g. 1999) discusses creativity as a system, while Cropley et al. (2017) highlight the properties of a system in the context of creativity. Like any complex system, creativity cannot simply be reduced to its components, without losing the vital, emergent behaviour that results from the interaction of Person, Process, Press and Product.

While it may be the case that the creative Process – in the sense of the core divergent and convergent thinking skills – is a commodity (Table 1), when viewed as part of a complex system (Fig. 1), it is hard to make the case for the commoditization of creativity.

Fig. 1 shows that a creative Product is an emergent property of the system. The Product results from the interaction of a favourably disposed Person, equipped with (trained in) skills in divergent and convergent thinking, and operating in a supportive environment. Under these circumstances, we expect to see the generation of novel and effective (i.e. creative) products. In this *system*, only one element, Process, can be regarded as resembling a commodity. However, if some part of the system is not standardised, and is not a commodity, then it seems meaningless to treat the whole system as a commodity. Even though the system of creativity is valuable, and serves as an enabler of other outcomes, and even though the core process is essentially standardised, creativity as a whole is too highly differentiated to be a commodity.

Florida (2002) touched on a similar conclusion, albeit via a different pathway: “Thus, creativity has come to be the most highly prized commodity in our economy — and yet it is not a ‘commodity’. Creativity comes from people. And it annihilates the social categories we have imposed on ourselves. A Creative Economy requires diversity because every human is creative ... In doing so, it has pulled off yet another astonishing mutation: taking people who would once have been viewed as bizarre mavericks operating at the bohemian fringe and placing them at the very heart of the process of innovation and economic growth”.

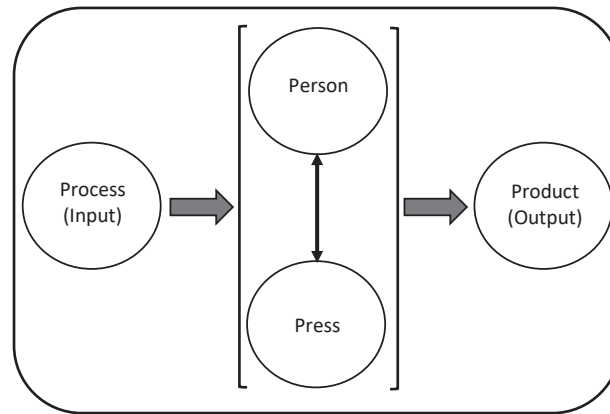


Figure 1 The System of Creativity.

Conclusions

On the one hand, the core creative Process may resemble a commodity. On the other hand, it appears that creativity, as a system, is *not* a commodity. Does this matter, and does it impact on creativity theory and practice?

Commodities are raw materials. They are the inputs that, via value-adding processes, become solutions to problems. Gold is a commodity; it is a raw material extracted from the ground, and with little further processing, or development, is sold on the open market. Gold, in itself, is not a solution to a problem. It is, however, an input to a problem-solving process that can turn gold into, for example, a reflective coating for an astronaut's helmet.

Creativity, as the system of interacting elements (people, process, environment (press) and product) is not a commodity. It is not a *raw material*, and not a *natural resource* (which, by definition, exist without the actions of humankind). It is, rather, the differentiated and developed system that results in solutions to problems. Divergent thinking, in the sense of a standardised input, or *raw material*, may resemble a commodity. However, even that, with the proliferation of differentiated techniques, tools and methods (e.g. Brainstorming or Design Thinking) appears less and less like a commodity.

The question of the commoditization of creativity may be driven by an underlying desire to demonstrate the value of creativity. Commodities have value and are subject to supply and demand. When scarce, the value increases, and when plentiful, the value decreases. However, this view seems to be flawed when applied to creativity, for the simple reason that creativity is not a *zero-sum game*. The fallacy of regarding any aspect of creativity as a commodity can be seen in the following thought experiment: What if all people on Earth were trained in divergent thinking? In other words, what if there was an oversupply of divergent thinking? Would this render divergent thinking of no value? Of course not! Indeed, it is easier to imagine that more creative solutions would be generated, and that the perceived value of creativity would increase!

To repeat, creativity is not a zero-sum game; there is not a finite amount of creativity available to humankind. In fact, creativity may be better thought of as a *technology*. Pilzer (1990) describes this phenomenon through the concept of *economic alchemy*. He argued that a society's wealth is a function of the physical resources (i.e. commodities) available to it, with the *availability*, and value, of those physical resources determined by technology – "technology controls both the definition and the supply of physical resources" (p. 2). It follows, therefore, that "In fact, for the past few decades, it has been the backlog of unimplemented technological advances, rather than unused physical resources, that has been the determinant of real growth" (p. 2). This can be taken a step further by suggesting that it is a *lack of innovation* (i.e. *unexploited creativity*) that has prevented growth from reaching its real potential.

Creativity is an element of human capital. It exists in varying degrees in people and can be developed. It serves as a vital input to problem solving processes, giving it economic value. Creativity is, in fact, *much more* than a commodity.

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Compensatory Advantage

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Introduction

Why do some of the world’s most eminent creatives seem to be a little *off*, *different*, or even *crazy*? Notions of the “Mad Genius” hark back to times of Aristotle and Plato, forming a strong foundation for the assertion that creativity and psychopathology are somehow related. Both empirical and anecdotal evidence point to a compensatory advantage associated with genes that increase vulnerability to psychopathology: individuals with two dominant genes demonstrate severe psychopathological symptoms, but those with just one dominant gene often reap the benefits of increased creative capabilities.

Psychotic patients face many struggles, ranging from difficulties with maintaining employment to social isolation, low reproductive success, and a high risk of early death from suicide. Given these disadvantages, why have the genes associated with vulnerability to psychotic disorders not been selected out of the gene pool? Many researchers have proposed that the disadvantages of psychosis must be balanced by some advantages; in short, there must be some “good” that comes from genes related to psychosis, for otherwise they would no longer exist.

A similar conundrum can be found in the case of sickle-cell anemia, a condition in which there is a lack of healthy red blood cells to carry adequate oxygen throughout the body. Individuals homozygous (with two mutant genes) for sickle cell suffer from severe anemia and health issues that often result in early death. However, those who are heterozygous carriers (with one mutant gene and one normal gene) seldom suffer from symptoms—and benefit from an increased resistance to malaria. Thus, the threat of severe anemia in homozygous individuals is balanced by the benefit of resistance to malaria seen in heterozygous carriers. This *heterozygote advantage* is one explanation for the persistence of sickle-cell genes throughout generations, and several researchers have pointed to a similar advantage when investigating the convoluted relationship between creativity and psychopathology: “it is the presence of subclinical psychological characteristics associated with genetic liability or susceptibility to certain mental illnesses, rather than overt psychopathological symptomatology, that actually aid creativity” (Gostoli et al., 2017, p. 63). Such assertions are supported by numerous examples of eminent creatives who have suffered from severe mental disorders, leading to the conclusion that “madness may be the price for possessing one of the most sublime human gifts” (Barrantes-Vidal, 2004, p. 59).

Addressing the “Mad Genius” Stereotype

The “Mad Genius” controversy has historically been a polarizing issue among researchers. Indeed, humanistic and positive psychologists are quick to argue that creativity is a sign of superior mental health, or self-actualization. However, it is important to note that those who believe there is a relationship between creativity and psychopathology would likely question blunt claims that all creative geniuses are insane. *Rather than a direct correlation between creativity and psychosis, highly creative individuals share unique cognitive and dispositional traits with those who demonstrate vulnerability for mental or emotional instabilities.*

Lombroso's (1891/1985) work, *The Men of Genius*, investigated the relationship between creativity and the predisposition to mental illness. It suggested that genius was an evolutionarily beneficial form of insanity. A genetic link between creativity and psychosis reveals that relatives of the mentally ill are likely to carry mild forms of psychotic traits, which are thought to enhance creativity. Indeed, research has revealed that creative individuals are at a higher risk for various forms of psychopathology, such as mood disorders, schizophrenia spectrum disorders, substance abuse, ADHD, and autism.

Richards et al. (1988) were first to use the term "*compensatory advantage*" (p. 281) to describe the intriguing relationship between creativity and psychopathology. While others before Richards had proposed a connection between creativity and mood disorders, this team of researchers was the first to suggest that the *degree* of psychotic dysfunction was key to unraveling the "Mad Genius" phenomenon.

Evidentiary Support for Compensatory Advantage

Three main types of studies demonstrate that genes which increase vulnerability to psychopathology also provide a compensatory advantage for creativity: (1) historiometric studies, which systematically analyze archival data concerning eminent creatives throughout history; (2) psychiatric studies, which investigate the mental health of present-day creatives; and (3) psychometric studies, which rely on standard assessment instruments to measure both creativity and vulnerability to psychosis.

Historiometric Evidence

Historiometric studies systematically analyze the biographies of prominent creators, in search of symptoms similar to various psychopathological syndromes. Such research has revealed the rate and intensity of psychopathological symptoms to be higher among prominent creators than in the general population, the most notable difference in symptoms existing between high achieving artists and noncreative controls. One does not need to look far for examples of eminent creatives who fit this description. Take, for example, names such as Robin Williams, Vincent Van Gogh, Robert Schumann, Mozart, Beethoven, Sylvia Plath, Virginia Woolf, Anne Sexton, Ernest Hemingway, Edgar Allan Poe, Michelangelo, Georgia O'Keeffe, and Jackson Pollock. While these individuals are well-known for their impressive creative lifestyles and contributions, their lives also tell the story of mental struggles and instability.

Historiometric studies have generally provided convincing evidence for the posited relationship between creative achievement and mood disorders, the most notable being depression and correlates of alcoholism and suicide. Studies have revealed that creativity and mental illness seem to run in the same family lines; genealogies which produce some of the most eminent creators are intriguingly characterized by higher rates and intensities of psychopathological symptoms. Interestingly, historiometric studies have revealed that the intensity of mental illness symptoms varies with specific domains of creativity: one study revealed that British and Irish poets from 1705 to 1805 displayed mood disorders, suicide, and institutionalization at *twenty times* that of the normal population!

Psychiatric Evidence

Psychiatric research depends on the selection of prominent present-day creatives and the subsequent analysis of clinical diagnosis and therapeutic treatment of such individuals. As demonstrated by historiometric studies, such research has revealed a higher rate and intensity of psychotic symptoms associated with creative individuals, particularly those who express creativity in the artistic domain.

Investigations of some of today's most prominent writers have revealed a higher rate of mood disorders in these artists than in matched control groups. Furthermore, first-degree relatives of prominent creatives have been shown to be more likely to demonstrate characteristics of mood disorders and creative achievement than relatives of control subjects, suggesting that the "Mad Genius" trait could indeed be genetically heritable. One study revealed that first-degree relatives of hospitalized psychiatric patients were twice more likely than the normal population to be employed in creative professional fields.

Psychometric Evidence

Psychometric studies use standard assessment instruments (e.g., the Minnesota Multiphasic Personality Inventory and the Eysenck Personality Questionnaire) to assess vulnerability to psychosis in creative individuals. Creativity has been shown to positively correlate with psychoticism scores on the Eysenck Personality Questionnaire, and, once again, artistic creators demonstrate more elevated scores than scientific creators. Nonparanoid schizophrenia patients have traditionally scored higher than other groups on the 'unusual uses' test, which assesses the production of original and novel ideas. Research has also indicated that hypomanic and normal relatives score higher than manic-depressives and controls on the lifetime creativity scale.

Psychometric research is particularly informative, as evidence has revealed that the relationship between psychosis and creativity seems to lie on a continuum: eminent creatives often demonstrate a less severe form of psychosis, and thus are able to "take advantage" of being a carrier of these genes while avoiding the negative symptoms that occur with more extreme cases. Indeed, highly creative individuals typically score about midway between normal and abnormal ranges on tests of psychological symptoms.

Not All “Madness” Is the Same

It is important to note that the relationship between psychopathology and increased creative potential varies across specific types of mental disorders. Originally, the association between creativity and psychopathology was believed to mainly lie in the schizophrenic spectrum, but recent researchers argue creativity to be more clearly linked to the bipolar spectrum and mood disorders. Thus, very general statements such as “individuals with psychopathological disorders always benefit from increased creative potential” are much too general.

Explanations of the Compensatory Advantage Mechanism

Why does a mild hypomanic state benefit creative achievement? Various researchers have investigated the association between creativity and psychopathology, proposing unique terminology to expound upon the compensatory advantage mechanism.

The “Creativity Cluster”

Creative production is rooted in both the cognitive ability and emotional willingness to “think outside of the box”. [Simonton \(2005\)](#) proposed a “creativity cluster” of traits that equips individuals to engage in creative thought: defocused attention, divergent thinking, openness to experience, independence, and nonconformity. Several of these traits are also common among individuals vulnerable to psychopathology. For example, elevated scores on psychoticism are associated with both independence and nonconformity.

Eminent creatives are more likely to display traits in the “creativity cluster”, and thus likely to display traits indicative of psychopathology (of course, with the important caveat that psychopathological symptoms are not the sole source for the underlying cognitive and dispositional attributes of creativity). Indeed, research has revealed it is important not to conclude a causal relationship between psychopathology and creativity, but rather to maintain the assertion that the two share a common set of traits.

The Shared Vulnerability Model

The “dose-dependent” association between creativity and psychopathology asserts that mild doses of madness are beneficial to creativity, while heavier doses can be detrimental to creativity and life as a whole. Others have described this relationship as an inverted-U shape, emphasizing that creativity and psychopathology are positively correlated until the degree of psychopathology becomes so intense that it “overcomes” the individual, and the association with creativity weakens.

[Carson’s \(2011\)](#) Shared Vulnerability Model is consistent with the theory proposed by [Richards et al. \(1988\)](#) and implies that creativity and psychopathology share common genetic mechanisms which, depending on the presence or absence of protective factors, can manifest in a positive (enhanced creativity) or negative (psychopathic symptoms) manner. Research has demonstrated three main shared vulnerabilities: (1) reduced latent inhibition, (2) novelty seeking, and (3) neural hyperconnectivity.

Reduced Latent Inhibition

Latent inhibition is a filtering mechanism that screens irrelevant stimuli, thus focusing the mind on the most pressing and practical issues at hand. Research has shown low latent inhibition to be correlated with high creative achievement; the ability to simultaneously focus on relevant and irrelevant tasks leads to creative associations that often produce original ideas. In short, reduced latent inhibition brings more stimuli into the conscious awareness, increasing the supply of ideas and setting the stage for original and flexible thought. Eminent creatives have been shown to be seven times more likely to have reduced latent inhibition than noncreative counterparts, and research has also demonstrated an association between reduced latent inhibition and psychopathological syndromes.

Novelty Seeking

Novelty seeking is a common risk factor for psychopathology. Those who struggle with alcohol abuse and addiction are often driven to experience the “next new thing”, and research has shown that individuals with bipolar and substance abuse disorders score significantly higher on measures of novelty seeking than the control. Creatives are also likely to seek novel and complex stimuli; indeed, such an intrigue for the unknown may be the underlying motivational factor to attend to new ideas discovered partly due to reduced latent inhibition.

Neural Hyperconnectivity

Yet another shared vulnerability factor is neural hyperconnectivity. Such hyperconnectivity is common among schizophrenics and close relatives, and often thought to be the underlying mechanism for bizarre associations which are the characteristic symptom of the condition. Interestingly, hyperconnectivity is also common among creative individuals. Brain-imaging studies have revealed unusual patterns of connectivity among creatives, and the ability to synthesize such remotely associated ideas is thought to form the basis of creative production.

Protective Factors

What allows individuals to harvest the benefits of psychopathological syndromes, rather than letting the symptoms control them? Protective factors such as ego-strength, self-sufficiency, intelligence, and working memory capacity have been shown to exert control over psychopathological syndromes. For example, individuals with high IQs may be able to systematically process additional stimuli that result from reduced latent inhibition, while those with lower IQs are more likely to be overcome by such a surplus of stimuli and tend toward psychosis. Indeed, the combination of reduced latent inhibition and high IQ predicted an impressive 30% of the variance in creative achievement scores in Carson and his colleague's study of eminent creative individuals (Carson et al., 2003).

Working memory capacity may also serve as a protective factor; those with a higher capacity are able to attend to and process the surplus of stimuli which may result from altered states of consciousness that stem from reduced latent inhibition, mood disorders, or other psychopathic symptoms. Cognitive flexibility, closely related to the openness to experience trait that often characterizes creatives, may also equip individuals to successfully adapt to and utilize increased stimuli.

In further support of the importance of protective factors, research has revealed that while eminent creators demonstrate high psychopathology scores, they also demonstrate high levels of ego strength and advantages in both abstract and cohesive thinking.

Experiencing *Just Enough* “Madness” Increases Creativity

Put simply, there seems to be “sweet spot” between creativity and psychopathology: factors common to both creativity and psychopathology increase access to ideas being processed below conscious awareness, but protective factors exert executive monitoring and control over this access. Thus, individuals are able to take advantage of unusual (and often bizarre) thoughts, but not be overcome by them and drawn into madness. Indeed, many creative achievers prefer to tolerate mental symptoms, rather than take pharmaceuticals which they fear may lessen the creative ideas which result from minor forms of madness. As Richards (1996) claimed, “a-ha moments of creative insight often resemble an edge-of-chaos phenomenon” (p. 71).

Despite the seemingly polarizing nature of the “Mad Genius” debate, there is a general consensus that less severe cases of psychopathology are associated with creativity. The concept of compensatory advantage (and the alternative labels for it) provide an explanation for why subclinical levels of certain forms of psychopathology are related to creativity. It might be that the notion of a “Semi-Mad Genius” would be more accurate than “Mad Genius”!

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Competition[☆]

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Many people believe that creativity benefits from competition, the activity or condition of striving to gain or win something by defeating or establishing superiority over others. This is reflected in the many contests or awards to procure creative ideas and innovative products. For instance, science foundations stimulate competition among scientists by awarding grants to the most promising research proposals; the online television company Netflix created a \$1 million prize for innovations that would improve the accuracy of its movie recommendation algorithm by 10%; and companies increasingly use open innovation tournaments where people can win prizes with their suggested problem solutions. The idea that competition fosters creativity is also fueled by anecdotal evidence that rivalry was at the basis of creative genius, for instance for the musicians Lennon and McCartney and the scientists Max Perutz, James Watson, and Francis Crick.

Notwithstanding the popular belief that competition promotes creativity, empirical research on the effects of competition on creativity reveals mixed findings. Some research findings demonstrate that people are more creative when competing with each other (e.g., [Beersma and De Dreu, 2005](#); [Chen and Chiu, 2016](#)). However, other studies found that competition negatively impacts creativity ([Amabile, 1996](#); [Erat and Gneezy, 2016](#)). Even more commonly, neither positive nor negative main effects of competition on creative performance are obtained (e.g., [Baer et al., 2013](#); [Baas et al., 2019](#); [Zhu et al., 2018](#)).

Further complicating the question whether competition is beneficial or detrimental to creativity is that this question may be answered at different levels of analysis; competition may have different effects for individual creativity than for group-level creativity. This suggests that rather than simply asking the question whether competition fosters creativity, we should instead ask when and for whom competition promotes or prevents creativity. The goal of this Encyclopedia entry is to provide answers to the latter question. This entry reviews the effects of competition at the individual and group level and identifies moderators that determine the sign and size of the effect of competition on creativity. The literature is summarized by discussing broad trends and developments.

Competition at the Individual Level

When Competition Motivates Reduced or Enhanced Creativity

Theories that predict a negative effect of competition emphasize that competition triggers the “wrong” motivation. Whereas creativity benefits most from intrinsic motivation, in which the creative act is enjoyed, interesting, and an end in itself ([Amabile, 1996](#)), competition leads to extrinsic motivation, driving people to engage in a creative act to pursue an ulterior end (e.g., a prize, status; [Amabile, 1996](#)). This increases feelings of being controlled and may lead to distraction by the prize or opponent, hampering creativity ([Amabile, 1996](#)). The detrimental effects of competition-induced extrinsic motivation on creativity have been demonstrated in a classic study among children by Amabile in 1982. Children generally enjoy creating and building. Non-competing children, that were intrinsically motivated, built more creative paper collages than extrinsically motivated children, that were competing with each other for prizes (see [Amabile, 1996](#) for a discussion of this study). This negative effect of competition on creativity has been replicated in other samples and with different tasks (e.g., [Amabile, 1996](#); [Erat and Gneezy, 2016](#)).

Theory that predicts positive effects of competition on creativity is based on the rationale that competition motivates people to increase their effort ([Eisenberger and Rhoades, 2001](#)). Indeed, creativity often involves hard work, takes time, and requires perseverance ([Baas et al., 2019](#)). Crucially, [Eisenberger and Rhoades \(2001\)](#) argued that it is essential that competing people know where

[☆] All authors declare that they have no conflict of interest.

to direct their efforts by informing them what specific type of performance is expected and valued. For instance, when specific performance criteria are absent, children making collages could focus on neatness instead of originality. However, when competing people know that creative performance is expected and valued, they can steer their effort and activities to meet this criterion, and competition should then foster creativity. This is indeed what studies on the effects of rewards on creativity show: Competition improves creativity when the reward is contingent on creative performance (e.g., [Eisenberger and Rhoades, 2001](#)).

Innovation contests are a specific type of competition where competitors know that creative performance is desired. In innovation contests, a company posts a problem to problem solvers. The problem solvers, either individuals or teams, submit plans or prototypes to the company and the best plan or prototype receives an award. Innovation contests work well to procure creative solutions. Importantly, in designing the contest, companies must decide how many problem solvers may compete. Increasing the number of competitors reduces the likelihood of winning for each problem solver. This increased rivalry reduces the incentives to invest effort and thereby lowers overall creative performance: Economists even argue that contests should be limited to two problem solvers to minimize underinvestment of effort ([Terwiesch and Xu, 2008](#)). However, a large number of problem solvers also increases the diversity of solutions and the likelihood of at least one good solution ([Terwiesch and Xu, 2008](#)). Moreover, this is especially the case when the problem is ill-structured and uncertain. Thus, the nature of the problem should be explicitly considered in designing innovation contests.

Although competition may foster creativity when it is clear that creative performance is desired, this beneficial effect may depend on whether men or women compete. Because women are less responsive to incentivized competition than men ([Erat and Gneezy, 2016](#)), gender represents an important moderator. Indeed, research findings show that whereas women were less creative in competitive situations, the creativity of males was either unaffected or enhanced in competitive situations (e.g., [Erat and Gneezy, 2016](#)).

In sum, whether competition improves or prevents creativity, or has no effect, depends on several factors: When people feel they are being extrinsically controlled by the competition, this reduces creativity. When performance criteria are specifically aimed at creativity, this increases creativity. Finally, gender moderates the effects of competition on creativity, with more negative effects for females than for men. However, the effect of competition on creativity may also depend on the type of creativity, a possibility that is explored next.

Malevolent Creativity

Creativity is often beneficial, however, people also generate novel ways to harm and hurt ([Baas et al., 2019](#)). Examples of malevolent creativity include data fabrication of scientists, dirty tricks in political campaigns and firms falsifying information. Provocative and threatening circumstances trigger malevolent creativity ([Baas et al., 2019](#)), so it is likely that competition increases creative malevolent responses.

Anecdotes support this notion. For example, to compete with Virgin Atlantic, British Airways resorted to dirty tricks, which included circulating rumors that Virgin CEO Richard Branson had HIV and telling Virgin's customers that their flights had been canceled. In addition, the fierce competition in science leads some scientists to perform biased peer review, sabotage competitors, and engage in questionable research practices.

There is also empirical support that competition breeds malevolent creativity. In studies conducted in our lab, people who were engaged in a competitive game against another person came up with more malevolent uses for a brick (e.g., using a brick as a weapon, or to sink a body) than non-competing others (see e.g., [Baas et al., 2019](#)). Together, these findings suggest that competition may also fuel a much darker side of creativity by facilitating the generation of ideas that are malevolent in nature.

Beyond Idea Generation

Most work on the competition-creativity link focuses on idea generation. However, following the idea generation stage, people must decide which idea or product to pursue and which to abandon, and ideas or products should ultimately be implemented. Although empirical research is sorely needed, some theoretical propositions have already been put forward. [Goncalo and Krause \(2010\)](#) proposed that competition may diminish idea selection performance, arguing that in a competitive climate, group members may derogate each other's ideas and refuse to compromise. It is also proposed that competition may diminish creative idea generation but enhance innovation implementation, because the need for innovation is perceived to be stronger. An important direction for future research would be to examine how competition impacts each stage of the creative journey, from the genesis of a creative idea to its ultimate implementation.

Competition as a Mindset

The studies in the previous sections examined the creative performance of people in competitive situations. Rather than being immersed in competition, people can also have a competitive mindset, i.e. more generally strive for individual achievement and to outperform others (also labeled performance approach orientation; e.g., [Goncalo and Krause, 2010](#)). Such a competitive mindset is positively related to self-perceptions of one's ability to generate creative ideas. A competitive mindset may foster creativity through this increased creative self-efficacy. Indeed, [Beersma and De Dreu \(2005\)](#) showed that competitive versus cooperative mindsets developed during a negotiation task influenced post-negotiation performance; those with a competitive mindset generated more

original advertisement slogans in a post-negotiation task. In addition, people with a stronger competitive mindset tend to produce more creative ideas (see [Goncalo and Krause, 2010](#) for an overview).

Although a competitive mindset may suffice for creativity when people work privately on fun tasks, additional requirements may be needed when working in the real world. In an organizational context, people work on real problems with more at stake and they have to overcome obstacles. Indeed, research often fails to find a main effect of a competitive mindset on creativity in field settings. However, a competitive mindset does appear to be positively related to creativity when people work in teams where learning and reflection is emphasized or work in organizations where rules are relatively unclearly specified and procedures unstandardized (e.g., [Hirst et al., 2011](#)).

In summary, competitive mindsets seem to increase the creativity of generated ideas, but in field settings, mixed results have been found regarding the impact of competitive mindsets.

Competition at the Group Level

Intragroup Competition

Creative performance in groups depends on the creativity of the input of individual group members and the way group members share, process, integrate, and build on this input to shape new ideas ([Hülsheger et al., 2009](#)). When individual performance within a group gets rewarded (henceforth intragroup competition), the creative input of individual group members may increase through an enhanced motivation to be more creative than everyone else in the group. Competition thus facilitates creativity in groups by motivating individuals to match or exceed the performance of highly creative group members. Related to this rationale, [Zhu et al. \(2018\)](#) observed that a competitive team climate did not significantly relate to creativity, but that it did positively predict extrinsic motivation. This, in turn, was associated with enhanced creativity for team members who had low intrinsic motivation. Intragroup competition could thus be effective when the creative project does not create interest on its own.

However, these beneficial effects of intragroup competition may be limited to conditions of low task interdependence. When the creative task requires the different group members to share knowledge, exchange ideas, and integrate their different perspectives, group creativity requires enhanced collaboration, cohesion, communication, and the constructive and open discussion of ideas ([Hülsheger et al., 2009](#)). Intragroup competition could disrupt these processes (e.g., [Amabile, 1996](#)): it leads to reduced collaboration among group members and a greater fear of being ridiculed by others. It also leads to a greater reluctance to share ideas and a rejection of knowledge by rivaling group members.

This is why [Amabile \(1996\)](#) identified destructive internal competition as an impediment for organizational creativity. In other studies, intragroup competition appeared to be unrelated or negatively related to group creativity. For instance, [Černe et al. \(2014\)](#) found that competitive rivalry in groups was negatively related to the creativity of individuals who tended to hide knowledge and information from other group members. In sum, intragroup competition can stimulate group members' extrinsic motivation and as such foster creative performance at the group level. However, this positive impact of competition seems limited to task contexts characterized by low interdependence. When creative performance requires group members to exchange and integrate information, competition reduces creative performance. Recent studies showed that some team members seem to suffer more from the latter effects than others, and an intriguing direction for future research would be to examine how intragroup competition may be structured to reap its' positive, but not negative effects.

Intergroup Competition

To spur creativity, companies often have different teams compete with each other. This intergroup competition increases effort in teams and leads to more unity, collaboration, and information exchange among group members ([Baer et al., 2010](#)), all processes that are conducive to creativity. [Chen and Chiu \(2016\)](#) indeed showed that partnering students competing with other groups were more engaged and creative than those that were not competing. [Baer et al. \(2010\)](#) also found that effects on creativity were positive for low to moderate intergroup competition, but then plateaued when competition became increasingly fierce. Apparently, intergroup competition pushes groups to be more collaborative and creative up to a certain point.

However, other findings suggest that performance-effects of intergroup competition depend on contextual factors and group composition. For instance, because men are more responsive to competition than women, [Baer et al. \(2013\)](#) showed that having groups compete against one another is stimulating to the creativity of groups composed mostly or exclusively of men but detrimental to the creativity of groups composed largely or exclusively of women. Moreover, [Baer et al. \(2010\)](#) uncovered that effects of intergroup competition on creativity were largely positive in static groups (groups in which no change in groups' membership occurs), but followed a U-shaped relation with creativity in fluid groups where groups exchanged a member with a competing group. The authors explained the latter finding by arguing that groups find it more difficult to adopt a collaborative mind-set toward past competitors than to shift from a collaborative to a competitive mind-set. This idea is supported by findings by [Beersma et al. \(2009\)](#) that showed that creating cooperation between former adversaries was more difficult than having former cooperators compete. The findings by Baer and colleagues also imply that a comprehensive understanding of the effects of intergroup competition on creativity requires the consideration of nonlinear effects.

As a final consideration, from an organizational perspective, it is difficult to imagine a structure where intergroup competition would not in the long run hurt organizational performance. Having groups, teams or departments compete with one another

presumes that they operate independently. With today's increasingly complex environment, this assertion becomes difficult to uphold. Longitudinal studies that assess the long-term effects of intergroup competition are currently lacking, but would be very worthwhile to shed light on the benefits and detriments of this type of competition over time.

Conclusions

The effects of competition on creativity depend on several factors. At the individual level, competition tends to lead to reduced creativity for women and if people's intrinsic motivation is undermined. Competition tends to lead to enhanced creativity for men, if creativity is a clear performance criterion, if people have competitive mindsets and if the content of ideas is malevolent in nature. At the group level, competition within groups may spur the creativity of individual group members, but is unlikely to have positive effects when group creativity relies on active collaboration and sharing of information and perspectives. Competition between groups tends to raise group creativity.

Future studies should examine the effects of competition on creative performance over time, in ongoing teams, and should examine the factors that help groups to reap the benefits of competition without suffering from its detriments. In any case, the current entry demonstrates that there is much more to the competition-creativity link than lay wisdom suggests.

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Componential Models of Creativity[☆]

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Glossary

Component In the context of this article, one of the elements that in some combination constitute creativity in a person or product

Domain An area of creative endeavor, such as physics or painting. There is no generalized agreement as to what the domains of creativity are

Intelligence The ability to learn and to adapt to environments

Knowledge The organized body of information that serves as a jumping-off point for creative thinking. It is a prerequisite to creative thinking

Motivation One's level of involvement in an activity; the energy one brings to one's creative or other activities

Style A preference in the use of one's thinking or learning

Definition of Componential Models

A componential model of creativity is basically one that seeks to specify the basic components, or elements, that work together to produce creative behavior. Some works on creativity hypothesize that multiple components must converge for creativity to occur (Sternberg et al., 2004).

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Components Derived From Folk (Implicit) Conceptions of Creativity

Robert Sternberg (1985), for example, examined laypersons' and experts' conceptions of the creative person. People's implicit theories contain a combination of cognitive and personality elements, such as "connects ideas," "sees similarities and differences," "has flexibility," "has aesthetic taste," "is unorthodox," "is motivated," "is inquisitive," and "questions societal norms." This work suggests that the basic components of creativity are not to be found within any single branch of psychology or any other field – cognition, personality, or social psychology, for example – but rather cross these different branches.

On the one hand, lay theories of psychological phenomena are useful because they give us some insight into how people make judgments about creativity in their everyday lives. How do they assess not only other people's creativity, but also their own? On the other hand, lay theories lack the benefit of the expertise that researchers on creativity can provide, as illustrated below.

Components Derived From Explicit Theories of Creativity

Amabile

At the level of explicit theories, Teresa Amabile (1996) and her colleagues have described creativity as the confluence of intrinsic motivation, domain-relevant knowledge and abilities, and creativity-relevant skills. The creativity-relevant skills include:

- (1) a cognitive style that involves coping with complexities and breaking one's mental set during problem solving;
- (2) knowledge of heuristics for generating novel ideas, such as trying a counterintuitive approach; and
- (3) a work style characterized by concentrated effort, an ability to set aside problems, and high energy. An important feature of this model is that it points out that creativity involves styles as well as abilities – that is, preferences in ways of thinking. It also points out the importance of sheer hard work in achieving creative solutions to problems.

Baer and Kaufman

John Baer and James Kaufman (2010) have proposed an amusement-park model of creativity, wherein the researchers analogize the components of creativity to the components of moving around through an amusement park. For example, one has to pick a section of the amusement park in which to walk and then has to pick specific things to do within the amusement park, just as one has to pick a domain in which to do creative work and then a specific problem or set of problems within that domain.

Gruber

The late Howard Gruber (1974) and his colleagues proposed a developmental *evolving-systems model* for understanding creativity. A person's knowledge, purpose, and affect grow over time, amplify deviations that an individual encounters, and lead to creative products. Developmental changes in the knowledge system have been documented in cases such as Charles Darwin's thoughts on evolution. Purpose refers to a set of interrelated goals, which also develop and guide an individual's behavior. Finally, the affect or mood system notes the influence of joy or frustration on the projects undertaken. Gruber's model emphasizes that components of creativity cannot be understood merely additively. That is, one cannot simply list components and ask a person whether he or she is at some reasonably high level on some or all of them. Rather, one must look at how they interact systemically in order to determine whether a person does and is likely in the future to continue to produce creative work.

Csikszentmihalyi

Mihalyi Csikszentmihalyi (2013) took a different "systems" approach and highlighted the interaction of the individual, domain, and field. An individual draws upon information in a domain and transforms or extends it via cognitive processes, personality traits, and motivation. The field, consisting of people who control or influence a domain (e.g., art critics and gallery owners), evaluates and selects new ideas. The domain, a culturally defined symbol system such as alphabetic writing, mathematical notation, or musical notation, preserves and transmits creative products to other individuals and future generations.

Gardner

Other work complements that of Csikszentmihalyi. Howard Gardner (2011) and his various colleagues over the years conducted case studies suggesting that the development of creative projects may stem from an anomaly within a system (e.g., tension between competing critics in a field) or moderate asynchronies between the individual, domain, and field (e.g., unusual individual talent for a domain). In particular, Gardner analyzed the lives of seven particular individuals who made highly creative contributions in the twentieth century, with each specializing in one of the multiple intelligences: Sigmund Freud (intrapersonal), Albert Einstein (logical-mathematical), Pablo Picasso (spatial), Igor Stravinsky (musical), T. S. Eliot (linguistic), Martha Graham (bodily-

kinesthetic), and Mohandas Gandhi (interpersonal). Charles Darwin would be an example of someone with extremely high naturalist intelligence. Gardner pointed out, however, that most of these individuals actually had strengths in more than one intelligence, and that they also had notable weaknesses in others (e.g., Freud's weaknesses may have been in spatial and musical intelligences). In the case of Gardner's model, the components are not so much additive as threshold determined. That is, the outstanding individuals Gardner cites are all people who excelled in one of the components of Gardner's model. They were not necessarily distinguished or even good at other components. For example, there is no reason to believe that Martha Graham would have excelled as a physicist, or Einstein, as a dancer!

Although creativity can be understood in terms of uses of the multiple intelligences to generate new and even revolutionary ideas, Gardner's analysis goes well beyond the intellectual. For example, Gardner pointed out two major themes in the behavior of these creative giants. First, they tended to have a matrix of support at the time of their creative break-throughs. Second, they tended to drive a "Faustian bargain," whereby they gave up many of the pleasures people typically enjoy in life to attain extraordinary success in their careers. However, it is not clear that these attributes are intrinsic to creativity, *per se*; rather, they seem to be associated with those who have been driven to exploit their creative gifts in a way that leads them to attain eminence. Gardner further followed the path of collaborator Csikszentmihalyi in distinguishing between the importance of the domain (the body of knowledge about a particular subject area) and the field (the context in which this body of knowledge is studied and elaborated, including the persons working with the domain, such as critics, publishers, and other "gatekeepers"). Both are important to the development, and ultimately, the recognition of creativity.

Sternberg and Lubart

A confluence theory also was proposed by Robert Sternberg and Todd Lubart's (1995) *investment theory of creativity*. According to this theory, creative people are ones who are willing and able to "buy low and sell high" in the realm of ideas. Buying low means pursuing ideas that are unknown or out of favor but that have growth potential. Often, when these ideas are first presented, they encounter resistance. The creative individual persists in the face of this resistance, and eventually sells high, moving on to the next new or unpopular idea.

Research within the investment framework has yielded support for this model. Some of this research has used cognitive tasks such as (1) writing short stories using unusual titles (e.g., "the octopus' sneakers"), (2) drawing pictures with unusual themes (e.g., "the earth from an insect's point of view"), (3) devising creative advertisements for boring products (e.g., cufflinks), and (4) solving unusual scientific problems (e.g., how we could tell if someone had been on the moon within the past month). This research showed creative performance to be moderately domain specific, and to be predicted by a combination of six distinct but interrelated resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment.

Sternberg and colleagues showed that it was possible to distinguish a factor for creative thinking from factors for analytical and practical thinking. Including creative items in assessments for college admissions increased prediction of freshman-year success in college and also reduced relative differences among students of different ethnic groups. Subsequent work showed that measures of creativity improved not only prediction of academic work, but also of meaningful participation in extracurricular activities.

In more recent work, Sternberg (2018) expanded his conception of components of creativity to include not only defiance of the crowd, but also defiance of the self and defiance of the Zeitgeist. In this triangular theory of creativity, people are creative to the extent that they can stand up to what others think; stand up to their own past beliefs; and stand up to their preconceptions of what the world must be like.

Rhodes

Mel Rhodes (1961) proposed early on that creativity could be understood within a four-P framework. The four P's are product, person, process, and press. The product, of course, refers to the creative idea or artifact that is judged to be novel as well as appropriate for some purpose. The person refers to the creator of the idea or artifact. The process refers to the way in which the creative act came to be—the mental steps involved. And press refers to the external pressures acting on a person, either to produce more or less creative ideas or artifacts.

Glaveanu

Vlad Glaveanu (2013) recently has proposed a "five A's framework" for understanding creativity that, in some ways, elaborates on Rhodes' framework. He has argued that each "A" in essence serves as a separate but interrelated component of the creative process. The first component is the actor, or the person who produces the creative product. But although creativity is often studied in the context of the person, the person is not sufficient for understanding creativity. One also must understand the action—or what it is that the creator does, and how he or she does it. Further, one must understand the artifact that the actor produces through his or her action. What is it about the artifact that makes it creative? Next one must understand the audience that makes the judgment as to what is creative, because creativity is always judged in a sociocultural context. Artifacts are not creative in themselves, but rather, in the context in which they are judged. And finally, one must understand the affordances, or

aspects of the environment, that allow (or do not allow) creativity to occur. What kinds of circumstances give rise to creativity, or the absence thereof?

James, Taylor, and Colleagues

James et al. (1999), James and Taylor (2010, and later Sternberg 2019 have distinguished among positive creativity, negative creativity, and neutral creativity. Their suggestion is that we must recognize that merely valuing creativity for its own sake is naive. Although creativity can be used for good ends, it also can be used for bad and even evil ends. Cropley and Cropley further have discussed the concept of malevolent creativity: Sometimes creativity is used to accomplish bad ends. It is important that, in understanding creativity, we seek to understand what components make creativity either positive or negative in its outcomes. Gardner, Csikszentmihalyi, and Damon have made a similar point in their discussion of good work.

General Aspects of Componential Theories

In general, confluence theories of creativity offer the possibility of accounting for diverse aspects of creativity. For example, analyses of scientific and artistic achievements suggest that the median rated creativity of work in a domain tends to fall toward the lower end of the distribution and the upper – high creativity – tail extends quite far. This pattern can be explained through the need for multiple and often diverse components of creativity to co-occur in order for the highest levels of creativity to be achieved. As another example, the partial domain specificity of creativity that is often observed can be explained through the mixture of some relatively domain-specific components for creativity, such as knowledge, and other more domain-general components, such as, perhaps, the personality trait of perseverance.

The various theories described above suggest at least six distinct but interrelated resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment. Although levels of these resources are sources of individual differences, often the decision to use the resources is the more important source of individual differences.

Intellectual Abilities

Three intellectual skills are particularly important: (a) the synthetic ability to see problems in new ways and to escape the bounds of conventional thinking; (b) the analytic ability to recognize which of one's ideas are worth pursuing and which are not; and (c) the practical-contextual ability to know how to persuade others of – to sell other people on – the value of one's ideas. The confluence of these three abilities is also important. Analytic ability used in the absence of the other two abilities results in powerful critical, but not creative thinking. Synthetic ability in the absence of the other two abilities results in new ideas that are not subjected to the scrutiny required to make them work. And practical-contextual ability in the absence of the other two may result in the transmittal of ideas not because the ideas are good, but rather, because the ideas have been well and powerfully presented. To be creative, one must first *decide* to generate new ideas, analyze these ideas, and sell the ideas to others.

Put another way, one first needs to be creative—to come up with a new idea. But once one comes up with an idea, one further has to use analytical skills to decide whether the idea is a good one. And finally, one has to use practical skills to convince other people of the worth of the idea.

Some studies have sought to test the role of intelligence in creativity through a variety of studies. Sternberg and colleagues presented 80 individuals with novel kinds of reasoning problems that had a single best answer. For example, they might be told that some objects are green and others blue; but still other objects might be *grue*, meaning green until the year 2000 and blue thereafter; or *bleen*, meaning blue until the year 2000 and green thereafter. Or they might be told of four kinds of people on the planet Kyrion: *blens*, who are born young and die young; *kwefs*, who are born old and die old; *balts*, who are born young and die old; and *prosses*, who are born old and die young. Their task was to predict future states from past states, given incomplete information. In another set of studies, 60 people were given more conventional kinds of inductive reasoning problems, such as analogies, series completions, and classifications, but were told to solve them. But the problems had premises preceding them that were either conventional (dancers wear shoes) or novel (dancers eat shoes). The participants had to solve the problems as though the counterfactuals were true.

In these studies, Sternberg and his colleagues found that correlations with conventional kinds of tests depended on how novel or nonentrenched the conventional tests were. The more novel the items, the higher the correlations of our tests with scores on successively more novel conventional tests. Thus, the components isolated for relatively novel items would tend to correlate more highly with more un-usual tests of fluid abilities than with tests of crystallized abilities. Sternberg and his colleagues also found that when response times on the relatively novel problems were componentially analyzed, some components better measured the creative aspect of intelligence than did others. For example, in the “grue–bleen” task mentioned above, the information-processing component requiring people to switch from conventional green–blue thinking to grue–bleen thinking and then back to green–blue thinking again was a particularly good measure of the ability to cope with novelty.

Other studies by Donald McKinnon and Frank Barron have suggested that there is a threshold effect for the role of intelligence in creativity. They suggested that intelligence is moderately correlated with creativity up to an IQ of about 120, but that after that, the

two constructs are largely unrelated. More recently, however, David Lubinski and Camilla Benbow have argued that the relation between intelligence and creativity remains moderate to strong throughout the entire range of IQ.

Knowledge

Concerning knowledge, on the one hand, one needs to know enough about a field to move it forward. One cannot move beyond where a field is if one does not know where it is. On the other hand, knowledge about a field can result in a closed and entrenched perspective, resulting in a person's not moving beyond the way in which he or she has seen problems in the past. Thus, one needs to decide to use one's past knowledge, but also decide not to let the knowledge become a hindrance rather than a help.

Work by Robert Weisberg and David Perkins has suggested that knowledge plays a strong role in creativity. They have found that when more creative people are compared to less creative ones, a major difference is in the depth and breadth of their respective knowledge bases. Peter Frensch and Robert Sternberg have suggested, however, that expertise can lead to entrenchment, and hence that experts who are very knowledge-able can become susceptible to being less creative because they are used to thinking in traditional ways.

Thinking Styles

With regard to thinking styles, one kind of style is particularly important for creativity, namely, a preference for thinking and a decision to think in new ways. Sternberg has referred to this as a "legislative style." John Cacioppo has spoken of need for cognition. Joseph Fagan has found that even infants can differ in their preferences for novelty. This preference needs to be distinguished from the ability to think creatively: someone may like to think along new lines, but not think well, or vice versa. It also helps, to become a major creative thinker, if one is able to think globally as well as locally, distinguishing the forest from the trees and thereby recognizing which questions are important and which ones are not.

Personality

Numerous research investigations by Frank Barron, Donald MacKinnon, and others have supported the importance of certain personality attributes for creative functioning. At one time, the Institute for Personality Assessment Research at the University of California, Berkeley, was devoted to uncovering the personality traits linked to creative performance. These attributes include, but are not limited to, willingness to overcome obstacles, willingness to take sensible risks, willingness to tolerate ambiguity, and self-efficacy. In particular, buying low and selling high typically means defying the crowd, so that one has to be willing to stand up to conventions if one wants to think and act in creative ways. Note that none of these attributes are completely fixed. One can *decide* to overcome obstacles, take sensible risks, and so forth. However, there can be little doubt that people differ in their general predispositions toward the personality attributes of creative thought.

The most important characteristic for creativity may well be a willingness to formulate problems for oneself rather than to accept the formulations of others. Once one accepts others' formulations, one often comes to the same conclusions that the others did. But many great creative discoveries, such as the importance of bacteria in causing illness, came about because scientists looked for entirely new mechanisms of causality rather than merely asking how those mechanisms already identified, such as "miasma" (bad smells or foul-smelling vapors), might work (in this case, to cause illness).

Motivation

Intrinsic, task-focused motivation is also essential to creativity. The research of Teresa Amabile (1996), Beth Hennessey 2019, and others has shown the importance of such motivation for creative work, and has suggested that people rarely do truly creative work in an area unless they really love what they are doing and focus on the work rather than the potential rewards. Motivation is not something inherent in a person: One decides to be motivated by one thing or another. However, the environment, discussed below, can play a major role in motivating people in one direction or another.

Environment

Finally, one needs an environment that is supportive and rewarding of creative ideas. One could have all of the internal resources needed in order to think creatively, but without some environmental support (such as a forum for proposing those ideas), the creativity that a person has within him or her might never be displayed. Teresa Amabile has found that in environments that do not encourage creativity, creativity is much rarer than in supportive environments.

Confluence

Concerning the confluence of components, creativity is hypothesized to involve more than a simple sum of a person's level on each component. First, there may be thresholds for some components (e.g., knowledge) below which creativity is not possible regardless of the levels on other components. Second, partial compensation may occur in which a strength on one component (e.g.,

motivation) counteracts a weakness on another component (e.g., environment). Third, interactions may also occur between components, such as intelligence and motivation, in which high levels on both components could multiplicatively enhance creativity.

Components of Creative Products

Robert Sternberg et al. (2002) have proposed that not only persons, but products, can be understood in terms of different components.

First, some kinds of creativity accept current paradigms or try to extend them.

1. *Replication*. The contribution is an attempt to show that the field is in the right place. The propulsion keeps the field where it is rather than moving it. This type of creativity is represented by stationary motion, as of a wheel that is moving but staying in place.
2. *Redefinition*. The contribution is an attempt to redefine where the field is. The current status of the field thus is seen from different points of view. The propulsion leads to circular motion, such that the creative work leads back to where the field is, but as viewed in a different way.
3. *Forward incrementation*. The contribution is an attempt to move the field forward in the direction it already is going. The propulsion leads to forward motion.
4. *Advance forward incrementation*. The contribution is an attempt to move the field forward in the direction it is already going, but by moving beyond where others are ready for it to go. The propulsion leads to forward motion that is accelerated beyond the expected rate of forward progression.

Second, other types of creativity reject current paradigms and attempt to replace them or put them together in some way.

5. *Redirection*. The contribution is an attempt to redirect the field from where it is toward a different direction. The propulsion thus leads to motion in a direction that diverges from the way the field is currently moving.
6. *Reconstruction/redirection*. The contribution is an attempt to move the field back to where it once was (a reconstruction of the past) so that it may move onward from that point, but in a direction different from the one it took from that point onward. The propulsion thus leads to motion that is backward and then redirecive.
7. *Reinitiation*. The contribution is an attempt to move the field to a different as yet unreached starting point and then to move from that point. The propulsion is thus from a new starting point in a direction that is different from that the field previously has pursued.
8. *Synthesis*. The contribution attempts to move the field by putting together ideas from a variety of paradigms and integrating them into a single conceptual framework.

The eight types of creativity described above are viewed as qualitatively distinct. However, within each type, there can be quantitative differences. For example, a forward incrementation can represent a fairly small step forward, or a substantial leap. A reinitiation can restart a subfield (e.g., the work of Leon Festinger on cognitive dissonance) or an entire field (e.g., the work of Einstein on relativity theory). Thus, the theory distinguishes contributions both qualitatively and quantitatively.

Domain Generality Versus Domain Specificity of Components of Creativity

An important question is whether the components of creativity are domain general or domain specific. The greatest challenge in understanding the domain generality versus specificity of creativity is in understanding the concept of a domain itself. Is literature a domain, or German literature, or modern German literature, or modern German literature in its original language, or what? Is cognitive psychology a domain, or psychology, or behavioral science, or social science? Because we have no good definition of a domain, we cannot, at this point in time, have a clear sense of exactly what domain-specificity means. Here, we recognize that domains may themselves be defined at varying levels of generality or specificity. There is not, at this time, any consensual definition of a domain.

First, creativity is, in part, an attitude toward life. This attitude can but does not necessarily extend across a variety of domains. That is, someone might adopt the mindsets that lead to creative thinking across domains, but they do not necessarily do so. Whether they do so or not will be one factor in determining the extent to which creativity is domain-general for a given individual. For example, one such attitude is that creative ideas do not necessarily sell themselves, and hence it often is necessary to sell one's creative ideas. One might adopt this attitude, say, in one's work, but not in one's personal life, or vice versa. Even within one's work environment, one might adopt this mindset, say, in one's interactions with objects but not with people, or vice versa. So domain generality will be a function of the extent to which an individual thinks with a creative mindset across domains. More of these mindsets will be described shortly.

Much of the attitudinal effect is captured through what was called above a *legislative style* of intellectual inquiry. A person with a legislative style is someone who enjoys coming up with new ideas. The ability to generate new ideas does not necessarily go along with a desire to generate such ideas. Someone may be more comfortable in thinking in traditional ways, even if he or she has the ability to think nontraditionally. In this case, the issue is not how well one can think creatively, but rather, how much one desires to think in this way. This desire may be mediated, in part, by socialization. In some societies and some religions, creativity is

discouraged. The individual may come to believe that one's conformity to existing norms is a good test of one's responsibility as a citizen. Extreme right-wing governments, for example – whatever they may call themselves – may encourage extreme conformity to a societal norm, which may or may not be for the common good.

A second variable in determining the extent to which creativity is domain-specific is knowledge. Typically, to think creatively in a domain, one has to know what is known in a domain to go beyond what is known. Someone who is knowledgeable is at an advantage to be creative in a domain. But the advantage is tempered by several factors.

First, some domains require very intensive knowledge, whereas other domains require more extensive knowledge. For example, to be creative today in neuroscience, one must be intensively knowledgeable about the workings of the brain and about the research that has been done to date on the brain. The research in this domain is expanding at a rapid rate, so one must constantly be working to keep up to date.

But in many domains, the most creative people are those who are broadly knowledgeable and whose expertise is not limited to one domain. For example, in psychology, many of the most creative scientists have been very broadly trained, often initially studying a discipline other than their primary one. For example, John Gabrieli, one of the most well-known of contemporary neuroscientists, majored in English as an undergraduate. The advantage that broadly trained people have is that they can bring ideas from one field into another. For example, Herbert Simon brought ideas from economics into psychology in his concept of satisficing. George Miller borrowed many of his ideas in psychology from linguistics. So being broadly as well as deeply educated enables one to enhance one's creative thinking, at the same time that it may mean that the individual gets a somewhat later start in his or her contributions to the field.

The situation becomes even more complicated, because expertise in a field can impair as well as facilitate creativity. One can become so used to seeing things in a certain way that one becomes less, not more creative with the development of expertise. So the acquisition of specialized knowledge does not necessarily facilitate creativity. It also can diminish it. Whether it enhances or diminishes it is largely a matter of attitude, as discussed below.

A third variable that affects the domain generality of creativity is the extent to which the environments in which one lives support creativity. An individual does not live in one environment, but rather, in a multitude of environments. For example, one's family may encourage creative thinking, but one's workplace may not, or vice versa. Certain religions are extremely intolerant of deviations from norms, and may even punish such deviations with death. So one might be allowed to be creative in one's work, but not one's religious beliefs, or vice versa, in the case that an organization for which one works insists on blind conformity to a set of norms. Someone may have creative attitudes and an extensive knowledge base, but not be allowed to use them in order to be creative.

In recent work, Sternberg and his colleagues showed that scientific reasoning in general, and scientific creativity in particular, represent a domain of cognitive functioning that is distinct from the domain represented by the content of standardized tests of abilities, such as the SAT and the ACT. These investigators asked college-aged subjects to think scientifically—for example, to generate hypotheses, generate experiments, or evaluate experiments. These are tasks represent the kinds of thinking in which scientific researchers engage on a day-to-day basis. Levels of performance on these scientific-reasoning tests emphasizing creativity consistently correlated with each other, but did not consistently correlate with scores on standardized tests used for college admissions (ACT, SAT). Indeed, some of the correlations with the standardized tests were negative.

Conclusion

Students of creativity generally agree that creativity is not a unitary phenomenon, but rather, a complex one involving distinct components. These components appear not to be strictly additive, but rather, interactive. Although there is some disagreement among theorists, there is general agreement that the components involve cognition, knowledge, personality, motivation, and environment, as well as perhaps other things.

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Composers

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Introduction

Composers – persons who write down music for later performance, especially in the Western classical tradition – are among the most revered and beloved of all creators. For experts and laypersons alike, classical figures like Johann Sebastian Bach, Wolfgang Amadeus Mozart, and Ludwig van Beethoven loom as iconic, paradigmatic creative personalities. Research on such individuals constitutes a significant line of scholarship within the study of creativity. Such inquiries include archival studies of deceased classical composers – their lives, careers, and first-person comments about their creativity – as well as observational, laboratory, and interview studies of contemporary composers. This entry summarizes extant findings on the creativity of composers and discusses their implications for conceptualizing the nature of creativity more broadly.

Composers: Scope and History

Musical creativity encompasses a wide range of activities. The topic of this entry – composers – refers specifically to a person writing, notating, or otherwise recording musical ideas in some permanent form for later performance. Composing should be distinguished from performance, where a musician interprets already-written notes by playing or singing them, and from improvisation, where a musician – sometimes with the aid of an initial melody or agreed-upon harmonic sequence – creates new music in a real-time performance. Certain musical traditions, like American jazz or Indian raga, blend the roles of composer, improviser, and performer, often situating musical activities within group collaboration. Nearly all classical composers in the mainline Western tradition have also been adept performers and improvisers; many have also been distinguished conductors, critics, theoreticians, or impresarios. However, the notion of the *composer*, as an individual who occupies a distinct role that is separable from other musical activities, remains the prototype of high-level musical creativity for many people, perhaps especially in the West.

The status of composers was not always so lofty. While archaeological evidence shows that music has been an important human activity for tens of thousands of years, a unique societal role for composers requires the development of some system of musical notation. Such traditions developed in ancient Greece and in the Gregorian chant of medieval Europe.

The phenomenon of composers as distinct creative personalities is more recent. Among the earliest composers whose names and music both survive are Léonin and Pérotin, who flourished about 800 years ago in France. For the next 600 or so years, composers remained reliant on official patronage by religious or civic officials and institutions in order to scrape together a living, and conditions for creation were far more restrictive than today. Most music was written to order for specific occasions, rather than being the expression of a creator's personal inspiration. Composition and performance practices and obligations were often heavily intertwined. Music publishing technology developed, but copyright enforcement was lax to non-existent. Stylistic conventions evolved, new instruments were invented, and composers pioneered new musical forms (including opera) and new musical styles. Throughout this time, despite the gradual maturation of the European musical tradition through the innovative genius of figures like Giovanni Palestrina, Claudio Monteverdi, Johann Sebastian Bach, Franz Joseph Haydn, and Wolfgang Amadeus Mozart, composers continued to be regarded mainly as hired craftsmen and entertainers, rather than autonomous creators.

Around the year 1800, Ludwig van Beethoven emerged as a pivotal figure in the history of European music composition. He was the first major composer to make a living without institutional patronage, instead earning money on the sale and performance of his music. Beethoven also pioneered a highly influential musical style, which developed the techniques of his predecessors into individually distinct works of greater scope, density, and expressive intensity than anything heard before. His reputation as an isolated, brooding, difficult individual, wholly dedicated to his personal creative activity, added to the Romantic veneer, establishing new expectations for what a composer should be. No longer mere craftsmen, composers became prototypes of the highest form of innovative creative genius, a conception that persisted among later composers – like Richard Wagner, Claude Debussy, Arnold Schoenberg, and Igor Stravinsky – within the Western tradition in the 19th and 20th centuries and up until the present.

Historiometric Studies of Composers

One benefit of the enhanced status of composers over the last two centuries has been an intense interest in preserving and cataloging their works – including, retrospectively, those of earlier musical giants. Indeed, composers are among the best-documented of all creators, in any domain. The complete works of most great composers (including sketches and fragments) have been compiled in comprehensive detail. In many cases, a work's date of composition can be reliably established, and measures of the impact of each work – like citations in music history books or counts of commercially available recordings – can also be easily obtained.

The method of using such a paper trail of archival evidence as the raw material for scientific studies of creativity is called historiometry, a powerful methodology pioneered by psychologist Dean Keith Simonton. Such research has several important benefits. One is high ecological validity, since it deals with *bona fide* great creators and real-world indices of musical success. Another is that historiometry lends itself to quantification (say, estimates of the amount of music produced in a particular year), which allows rigorous statistical testing of hypotheses about the nature of creativity – particularly about patterns of eminence and of creativity over the lifespan. (See Historiometry)

Overall Productivity and Eminence

One tenet of many perspectives on creativity (including Simonton's) is that a creator's ability to produce new works is a fair index of their creative potential and, all else being equal, their ultimate historical eminence. Historiometrically, then, one would expect exceptionally eminent creators to be among the most productive as well. Among composers, as in many other domains, this is the case. Indeed, among the most remarkable features of great composers' creativity was the astonishing ability of figures like Wolfgang Amadeus Mozart, Franz Schubert, and Georg Frideric Handel to compose world-class music in very short order, with major masterpieces sometimes only taking a few days or weeks, and to sustain this level of creative activity for decades. Positive correlations have often been made between a composer's productivity and eminence, as measured by counts of pages in music history books on which that composer was mentioned (Murray, 2003). Moreover, the distribution of eminence scores for composers echoes that of every other complex domain that has been studied: most creative musicians are clustered at relatively low levels of achievement, with a long upper tail culminating in the stratospheric eminence of the very, very greatest composers in history – by common consent, Beethoven, Mozart, Bach, and Wagner.

Lifespan Creativity Trajectories

Analyses of overall productivity and overall eminence, however informative, are still somewhat limited, in that they do not inform composers' longitudinal patterns of output – that is, how creativity varies as a function of age. This is an important and surprisingly complex question, since there are many ways of measuring variables like age and creative productivity. Composers do not all follow the same career path, and the markedly varied outputs of different composers means that great care must be taken when aggregating their data into statistical analyses.

Expertise and BVSR Models of Lifespan Creativity

Beyond such methodological issues, also at stake are theoretical perspectives on the nature of creativity itself. The two main views are Weisberg's (2006) expertise acquisition view of creativity, and Simonton's (2011) blind variation and selective retention (BVSR) view of creativity. The two theories make very different assumptions about the nature of creativity and posit different predictions about how creativity unfolds over the lifespan, with important implications for the extent to which creativity might be controlled or sustained.

The expertise acquisition view emphasizes the importance of a person accumulating a vast amount of domain-specific knowledge. A minimum of about 10,000 h of intensive immersion within the domain is required to enable high-level creativity. Deliberate practice involves great concentration and structuring specific training tasks to facilitate improvement in the skilled performance of some complex activity, like playing the piano. In acquiring such a domain-specific knowledge base, budding creators begin to put it

to use via the mostly rational goal-directed problem solving and decision-making processes that drive the creative process. The expertise view is thus optimistic about the likelihood of creators being able to control important aspects of the creative process. Thus, expert creators should be able to continue to improve longitudinally and to sustain their creativity indefinitely – though few details about how they might strategize to achieve this are typically articulated.

In contrast, [Simonton's \(2011\)](#) BVSR perspective emphasizes chance and serendipity in creativity. In this account, mental elements are continually combined below the threshold of consciousness as the raw material for creative ideation; the most promising combinations emerge into conscious awareness and are then actively developed into finished creative products. The classic BVSR model views the initial combination process as inherently blind; the processes of elaborating ideas into finished works and the social reception of those works are likewise regarded as too complex to be reliably guided. Thus, at no point is the creator in complete control of the creative process, and the optimal creative strategy is simply to produce a lot of work, hoping that some pieces will achieve recognition. In other words, quality emerges from quantity, in line with the results on overall productivity cited above. Counterintuitively, the BVSR view also predicts that the most prolific period of a creator's career should typically yield both their best work and the greatest amount of second-rate work. Compared to the expertise acquisition view, the BVSR view is more pessimistic about the prospects for systematically improving creativity with age. This is especially true if a creator is at the cutting edge of a domain, with few landmarks to guide their process or evaluation. However, the BVSR perspective also suggests that creativity might be sustained by simply maintaining high productivity, in line with its quantity-drives-quality dynamic.

Career Landmarks and Quantity Trajectories

Both the expertise acquisition and BVSR theories make plausible claims about the nature of creativity. These claims have been extensively tested, and data from the careers of classical composers have played an important role in this line of research. The most direct evidence comes from empirical studies in which creators' careers are quantified – for example, by career landmarks like the ages at which various composers began studying music, began composing, wrote their earliest acknowledged masterwork, wrote their best work, wrote their final masterwork, and stopped composing altogether. Some analyses of career landmarks support the expertise acquisition perspective, in that even musical prodigies require at least a decade of intensive musical study before producing original works of lasting value. However, expertise acquisition alone does not explain some other findings, which are probably more readily attributed to creative potential or talent. For instance, the *very* greatest composers begin studying and writing music earlier and their production of masterworks spans a far longer portion of their careers, compared to their less eminent counterparts ([Simonton, 1991](#)). (See Talent)

Such findings can be understood via a parsimonious mathematical model of the BVSR theory ([Simonton, 1997](#)), which yields the typical inverted, backwards J-shaped trajectory for quantity of creative output. Typically, a creator's productivity starts low, rapidly climbs, peaks around age 40, then gradually declines. Varying the parameters of the mathematical model changes the shape of the productivity trajectory. For example, greater creative potential increases overall productivity and broadens the age span encompassing the career landmarks described above, although with no change of predicted age for the creation of best work. All of these claims are consistent with empirical findings.

Quality Trajectories and Hit Ratios

Lifespan creativity can be operationalized in other ways as well. Rather than examining just a few career landmarks or assessing productivity by total output irrespective of quality, alternative measures take the differential quality of creative products into account – via recording counts, citations in music history books, or expert ratings. Studies along these lines ([Kozbelt, 2011](#); [Simonton, 2000](#)) often found a single-peaked age function for creative achievement, as with productivity. This suggests some benefit of expertise, since on average composers improved the quality of their creative work for long stretches of their careers.

Similar results have been found for another statistic for assessing composers' career trajectories: hit ratio, or the proportion of masterwork-level music to total music written in different time intervals in composers' careers. This measure assesses the ability of creators to learn to wisely invest their creative resources, arguably the key issue in sustaining creativity. In contrast to the expertise perspective, the BVSR view has explicitly posited an inability of creators to do so, and some earlier studies (like [Simonton, 1977](#)) found results along these lines, with no systematic change in hit ratio with age. However, later work suggests these efforts were marred by methodological and statistical limitations, as noted in the most extensive recent study of composers' longitudinal hit ratios ([Kozbelt, 2008a](#)). In that study, the complete works of 65 eminent composers were tabulated and weighted by performance time; each work's masterpiece status was operationalized by several measures. Works were assigned to five-year age intervals, synchronized across composers by age at first masterwork, and hit ratios were calculated for each interval for each composer. Results showed a single-peaked overall hit ratio trajectory, with a maximum around age 50, and with age accounting for more variability in hit ratio than in overall productivity. Reliable age effects held even during composers' mature periods and even when composers' greatest masterworks were removed from the dataset, inconsistent with the null relation between hit ratio and age posited by the BVSR perspective. Overall, great composers thus seem able to continue to sustain and improve the quality of their creative work for long stretches of their careers.

Variability in Career Trajectories

Just as important as the overall longitudinal trend is variability in creative styles and trajectories among individual composers. Some composers seem boundlessly productive; others are perfectionists who produce relatively little finished music. Some write music in many different musical forms; others specialize, writing mainly operas or songs. Some write highly accessible works in popular styles; others work in highly innovative ways, composing esoteric works that may push the boundaries of what even constitutes music in the first place. Some composers achieve fame early on; others work for most of their careers in relative obscurity. Some are prodigies or produce their best work at strikingly early ages; others take a long time to develop, only incrementally improving and composing their most highly regarded music in old age.

Making sense of such variability is a significant challenge for creativity researchers. Along these lines, Kozbelt's (2008a, 2011) large-scale archival studies examined the issue of variability in composers' careers and found that composers who wrote their single best works later in their careers showed stronger overall longitudinal increases in creativity. Thus, composers' greatest works are embedded in characteristic long-term career paths. Moreover, late-peaking composers showed *weaker* relations between average annual output and hit ratio across age intervals. This suggests that for late-peaking composers, quantity does not drive quality to the extent that it does for early-peaking composers. Late-peaking composers appear to have developed a kind of creative wisdom that allows them to invest their creative resources with greater perspicacity, in contrast to more hit-or-miss early-peaking composers (Kozbelt, 2008a).

Such striking individual differences in composers' careers have been interpreted via a framework proposed by economist David Galenson (2006), who proposed two main categories of creators: 'finders' and 'seekers.' Finders, or conceptual innovators, show great certainty during the creative process and prioritize originality and idea generation. They rebel against tradition and often change styles abruptly, and their reputations often rest on a small number of outstanding individual pieces, which they usually produce early in their careers. In contrast, seekers, or experimentalists, engage the creative process through trial and error and prioritize skill and the execution of ideas over their raw originality. Building on tradition, they develop slowly and surely, usually producing their best work late in their careers. Seekers' reputations tend to rest on an overall body of work of relatively consistent quality. Kozbelt (2008a, 2014) found that Galenson's model applied very well to classical composers, accounting for individual differences in career trajectories as well as compositional methods and concerns. Figures like Robert Schumann, Franz Liszt, Richard Strauss, and Igor Stravinsky were prototypical finders; those like Franz Joseph Haydn, Johannes Brahms, Giuseppe Verdi, and Béla Bartók were prototypical seekers. (See Longevity)

Differences among composers' career paths have also been explored in a study of so-called one-hit wonders in classical music – that is, composers whose reputations are due largely or exclusively to a single well-known composition (Kozbelt, 2008b). On average, one-hit wonders write their most acclaimed work at a younger age than do multi-hit composers, despite one-hit composers generally getting a later start in the domain. Not only did the two groups differ in age, but also in the kind of music they wrote. One-hit wonders' hits were typically songs or short instrumental pieces (genres where chance is more paramount), rather than large-scale works like symphonies. Indeed, few of the one-hit composers even attempted to write in such elite musical forms.

In sum, archival methods have illuminated many aspects of composers' lifespan creative output. On average, overall output, irrespective of quality, is given by an inverted, backwards J-shaped trajectory, as in many domains. Measures of work quality or hit ratio appear to show a similar trajectory, though with substantial individual differences. Some composers peak early, producing chancily innovative works; others pursue their craft and style more incrementally, producing a body of great work whose very best exemplars tend to be written late in their careers. Finally, it is worth noting that many of the basic findings on classical composers reviewed here have also been replicated on other samples, including Hollywood film composers and popular song writers.

Melodic Originality as an Index of Composers' Creativity

Beyond questions specifically about patterns of lifespan creative productivity and achievement, archival methods have informed other issues in the study of composers' creativity as well. In particular, one variable that has been subjected to decades of analysis is that of melodic originality (see Simonton, 1994). Originality in this context is defined statistically, as unusual sequences of notes. Given a large population of melodies, one can calculate the likelihood of particular notes in the musical scale being the first note in the melody, second note, and so on. Many melodies unfold very predictably, with certain transitions occurring frequently within the population. Other melodies are far more surprising, with unusual transitions occurring more often. Averaging over a measure of infrequency for each transition in a melody produces an overall sense of that melody's originality.

Quantitative measures of melodic originality can be statistically analyzed to examine many questions about musical creativity, since presumably the choice or construction of a melody represents an important decision-making aspect of musical composition. Indeed, a great melody can be the main driver of a work's popular or aesthetic appeal. Melodies are sometimes also seen as a window into the composers' state of mind. For instance, tortuously chromatic melodies are sometimes thought to be emblematic of a composer's mental distress at the time of composition.

Measures of melodic originality have been validated in several ways. For instance, research showed that originality is higher for melodies written in minor keys, compared to major keys – in line with the most exotic sound of minor-key music. Instrumental melodies are also higher in originality than vocal melodies – perhaps because of the inherent constraints in the human vocal apparatus compared to greater freedom on many instruments. More original melodies tend to be found in chamber or instrumental

works, where melody must carry more of the musical argument. This is especially true compared to theatrical works like operas and ballets, which tend to feature melodies lower in originality, perhaps because they contain many other performance features (scenery, narrative, and so on) that can contribute to a work's aesthetic impact. Melodic originality also correlated positively with ratings of compositions' aesthetic significance, a gauge of profundity and meaningfulness, and to correlate negatively with ratings of compositions' accessibility, essentially an 'easy-listening' measure.

Another question is how melodic originality changes over historical time. Stylistically, classical music has evolved through many styles: Renaissance, Baroque, Classical, Romantic, Impressionist, and Modernist are some of the most common labels. Within each major style, numerous sub-styles – due to geographic or temporal or individual differences – have also been identified. Melodic originality is one metric of how classical music has evolved. For instance, later styles tend to have more chromatic (off-key) notes than earlier styles. This reflects greater pressure on later composers to outdo their predecessors by producing more original and surprising musical themes. Empirical investigations of this issue, using a corpus of thousands of melodies, yielded findings in line with this intuitive trend. However, defining originality with respect to an overall population of melodies has its own methodological issues. For instance, highly productive composers with a recognizable style contribute more melodies to the overall repertoire, inherently making their melodies *less* original.

A related question concerns how melodic originality changes over the lifespans of composers. The research described earlier, on how creativity in general fluctuates over the lifespan, suggests that many composers may learn to become more creative over time. Some research on lifespan melodic originality is consistent with this, finding general increases in melodic originality with age (at least until composers' mid-fifties). However, other research, using somewhat different statistical methods, has failed to replicate these overall relations between age and melodic originality.

Many other aspects of composers' creativity – both external and internal – are apparent in studies of melodic originality. For example, on the external side, composers who were born and raised far from major centers of musical activity – where presumably pressure for novelty and innovation are lower – tend to show lower overall levels of melodic originality. Another external factor is that of warfare: works composed under wartime circumstances tend to show much higher variability in the originality of their constituent melodies than works composed during times of peace.

Internal or personal factors also appear to play a role in composers' melodic originality. For instance, a composer's overall level of productivity is inversely related to the melodic originality. That is, during periods of their careers when composers write the most music, the melodies in that music tend to be more pedestrian, suggesting a tradeoff between quality and quantity of output. Melodic originality also appears to intensify in periods when composers suffer from some critical physical ailment or high levels of mental stress. This finding is in line with the common belief that music represents a way for the composer to communicate emotionally with their audience.

A final phenomenon examined used measures of melodic originality (as well as aesthetic success) is the so-called swan-song phenomenon. Some research found that in the year or two preceding death, composers' works undergo a substantial transformation: melodic originality decreases, work length decreases, but the works themselves tend to be more popular and to garner more critical acclaim. This view of composers being able to concentrate their creative resources into a last testament of creativity is appealing, but as with some other findings on melodic originality, more recent research, using different statistical approaches, has questioned these earlier conclusions.

Other Historiometric Aspects of Composers' Creativity

Besides overall patterns of lifespan creative productivity and achievement and the multifarious studies using melodic originality as a variable, researchers pursued other lines of scholarly inquiry using archival measures. Two representative instances are discussed here.

One is related to some of the issues in lifespan creativity identified earlier – specifically, the extent to which creators can learn to reliably evaluate their own ideas and works, and to wisely invest their creative resources accordingly. Recall that the classic BVS perspective posited that doing so would be very difficult, but that subsequent evidence suggested that many composers do indeed continue to improve for much of their careers in work quality and in hit ratio. A classic example of this, much discussed in the creativity literature, is Beethoven. His famously effortful composition process involved making numerous sketches and drafts, with works evolving and sometimes changing radically in conception before taking their definitive form. In navigating and assessing this complex process, did Beethoven have a good sense of which works were likely to be seen as successful, or not? One case study (Kozbelt, 2007) thoroughly examined Beethoven's letters and contemporary accounts, to comprehensively catalog all instances where Beethoven rendered an explicit positive or negative verdict on any of his own compositions. The 70 works so identified were then assessed on posthumous measures of work quality or masterwork status. Results showed a strong positive association between Beethoven's own assessments and those of posterity, suggesting that Beethoven's sense of the differential quality of his work was well-calibrated. Interestingly, informal analyses of other composers' self-critical comments suggest that some composers (typically those who fall into Galenson's 'finder' category) are biased to regard most of their work in very positive terms, while others (typically those who fall into Galenson's 'seeker' category) may be biased toward harshly self-deprecatory comments about their own music (Kozbelt, 2012).

Another important issue in the study of composers' musical creativity, and one which has received lots of attention in the creativity literature more broadly, is the role of mental illness in creativity. Several notable composers – like Robert Schumann and Hugo

Wolf, who both died while institutionalized – appear to have had severe mental health problems. However, reliable data on the association between creativity and mental illness is difficult to obtain, especially for long-deceased creators, and this research area remains plagued with methodological and conceptual controversy. Such limitations have not held back some scholars from exploring this contentious area. For instance, in one recent archival study, [Simonton \(2014\)](#) examined the relation between alleged mental illness and creative eminence in several domains, including classical music. Different domains showed varied relations between the two constructs. Classical composers showed a slightly convex positive function of psychopathology on eminence, with peak average eminence associated with moderate levels of psychopathology. However, mental illness *per se* may be less directly important for creativity than the broader impact of diversifying experiences. As with many complex questions (including the classic nature vs. nurture issue), the relation between creativity and mental illness is a research area that is ripe for further exploration – through archival data as well as approaches that are grounded more in personality, developmental, social, and neurobiological aspects of psychology, as well as genetic studies.

Modern Composers at Work: Studies of the Creative Process

Beyond the use of archival data to explore questions like lifespan creativity among eminent but deceased composers, several other kinds of methodologies have allowed researchers to draw a rich picture of the composer at work ([Sloboda, 1985](#)). For instance, musicologists used composers' sketches and notebooks to understand their composition methods and creative processes. However interesting such inquiries may be, thoroughly understanding such sketches requires enormous attention and domain knowledge, as well as intensive interpretation, while typically yielding only provisional conclusions.

Beyond the evidence of their sketches, many composers also left first-person descriptions of their creative process. Some of these are quite famous, like Richard Wagner's dream-like account of hearing the low rumble of a stream, which served as the inspiration for the prelude to his opera *Das Rheingold*. However, as with sketches, such anecdotes require scholars to provide significant context and interpretation. Also, it is not always clear how trustworthy composers' claims about their creativity might be, particularly if they lack corroborating evidence. Some composers might make the creative process seem more Romantic and ineffable than it really was; others, more logical; others, more replete with difficulties. Moreover, cherry-picked anecdotes can be used to support any theoretical position ([Kozbelt, 2007](#)).

To minimize such problems, some researchers investigated the nature of composers' creative processes by more systematic interview and/or observational methods, sometimes supplemented with analyses of sketches and works-in-progress. In some observational studies, composers are asked to verbalize their thoughts while working. This can reveal much about a composer's concerns and goals. To cite just one example: [McAdams \(2004\)](#) conducted a case study of contemporary composer Roger Reynolds, using his notebooks, sketches, diagrams, recorded interviews, and the final score to document and understand the process by which a new work for piano, chamber orchestra, and computer-processed sound was created – in particular addressing how several significant compositional problems were solved.

Studies of the creative processes of contemporary composers have advanced numerous concepts relevant to understanding the creative process. These include the mental chunking of processes and strategies at both micro and macro levels, generative processes of problem proliferation and successive solution implementation, the deployment of synoptic planning versus heuristic ideation, generating rules in the course of music writing, cycle development and concern of coherence, and creative borrowing as crucial parts of creative cognition. While rooted in the study of composers, such theoretical concepts may also inform other domains and aspects of creative activity.

Moreover, beyond cognitive mechanisms and processes, self-regulation and self-monitoring processes also appear to be important for many aspects of complex problem solving, including music composition. Aspects of self-regulation appear to be vital for the development of high levels of expert performance, which in itself is a prerequisite for creative achievement. Both require high levels of motivation, and in the in the domain of music, substantial differences were found between beginners, novices, and experts in their knowledge and deployment of self-regulation strategies. As [Kozbelt's \(2007\)](#) case study of Beethoven's self-critical comments suggests, accurate self-monitoring and self-assessment processes may constitute an important – if still understudied – aspect of high-level creativity.

Conclusions and Implications

The study of classical composers represents one of the most enduring and informative aspects of research on Big-C creativity. Composers are perhaps the most intensively studied group of high-level creative personalities, and their well-documented lives and works are unusually amenable to statistical analysis and the testing of hypotheses about the nature of creativity. Archival research has been a particularly important facet of this line of inquiry. Researchers documented robust findings on lifespan creative output and achievement, the relation of output to eminence, and on quantifying trans-historical style changes in the domain.

Beyond such classic findings on composers as an aggregate, more recent research also often placed a greater emphasis on individuals. For instance, in the last couple decades, archival studies focused on understanding the substantial individual variability among elite creators. Some of this work highlights important theoretical points, such as the possibility that meaningful control and evaluation of the creative process might be more common than previous thought (at least from the classic BVSR perspective).

Recent research also emphasizes methodological points, such as the dangers of ignoring, downplaying, or averaging across creators of very different types, domains, or levels of productivity. Finally, archival research continues to play a vital role in studies of venerable themes in the study of creativity, like its relation to mental illness.

Beyond historiometric analyses of deceased composers, the study of contemporary composers – through interviews, think-aloud laboratory studies, and the examination of sketches and scores – represents another major inroad in understanding the process of musical composition. The advent of neuroimaging techniques, and their application to evermore complex and ecologically valid tasks, likewise promises to continue to advance knowledge of creativity among composers.

Through all these varied methods, the study of great composers has materially advanced knowledge of creativity. The conclusions from this line of scholarship have significant potential application to understanding creativity within many other domains and as a general phenomenon worthy of scientific study.

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Confucianism

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Introduction

This entry sketches a Confucian conception of creativity based on the teachings and example of Confucius as recorded in the *Analects* – a Chinese classical text that compiles the sayings and conduct of Confucius and his followers. Confucius or Kong Fuzi (c. 551–479 BCE) aspired to eliminate the political and social chaos of his time through his instruction and involvement in governance. In so doing, Confucius propounds insightful and unconventional ideas and practices that reveal his creativity, as this essay shall explain.

At the outset, it is helpful to briefly discuss East Asian understandings of creativity. Despite divergence of views on the definitions, contents, processes and outcomes of creativity, scholars general agree that creativity involves some form of newness or change (for helpful readings on the history of research on creativity, see [Albert and Runco, 1999](#)). East Asians, like their counterparts in Anglo-phone societies, associate creativity with attributes such as originality, imagination, intelligence, individualism and goodness (including both moral goodness and usefulness) ([Niu, 2012](#); [Niu and Sternberg, 2006](#)). But the precise formulations, parameters and expressions of creativity stem from and are shaped by local social, cultural, and historical contexts. Researchers have reported major differences between Western and Eastern conceptions of creativity. Creativity as manifested in incremental originality, progressive adaptation, alternation of existing schemes or practices over time, domain-specific development and a reinterpretation of tradition are more privileged in East Asia as compared to Western settings ([Niu and Sternberg, 2002](#)). East Asians are unlikely to look favorably on models and applications of creativity that call for a revolutionary break from the past, radical novelty and disruptive changes ([Kaufmann and Beghetto, 2009](#)). What is preferred instead are innovative ideas, mechanisms and systems that are premised on and extended from existing traditions and cultures ([Tan, 2016a, 2019](#)). East Asians also play up the ethical and communal dimensions of creativity by emphasizing moral goodness and societal contribution ([Rudowicz and Yue, 2000](#)). Self-cultivation is integral to creativity: individuals are exhorted to invest in self-transformation and perfection through internalizing and displaying personal and communal virtues ([Tu, 1985](#)).

This essay sheds further light on East Asian perspectives on creativity by focusing on a Confucian approach to and practice of creativity as found in the *Analects* (all the passages from the *Analects* were translated into English by the author). Confucius' conception of creativity is *in situ* (on site) that is contrasted with *ex nihilo* (out of nothing) ([Ames, 2011](#)). The former underlines situation where “the act of creating and self-creativity are inseparable” ([Ames, 2011](#), p. 254). *In situ* creativity, unlike *ex nihilo* creativity, does not foreground discrete agency, originality, novelty, retrospection and dependence on its origin as a source of value. Instead, *in situ* creativity is prospective by emphasizing the productivity and significance of constitutive relationships. In contrast to *ex nihilo* creativity that negates histories, processes, particularity, synthesis and the wholeness of experience, *in situ* creativity values the past, antecedents, contingencies, possibilities and harmonization. The rest of the entry shall expand on three salient features of Confucius' *in situ* creativity: normative tradition, context and human interdependence.

Confucius' *In Situ* Creativity

Normative Tradition

The first essential characteristic of Confucius' *in situ* creativity was his accent on realizing and perpetuating the normative tradition. Rather than ignoring or downplaying the past, Confucius averred that creativity should “keep alive the old in order to know the new” (*Analects* 2.11; all subsequent citations are from this text). Creativity is not *ex nihilo* but situated in concrete and localized histories, cultures and discourses. All modes of thinking, including creative engagement, need to be accompanied by the learning of one's culture ([Tan, 2015](#)). Confucius propagated the imperative to “learn culture broadly” (6.27); he shared that he “quietly stores up what is learnt and is insatiable in learning” (7.2, also see 7.17, 9.2). Commenting on his own mistake, he said: “I once went without food the whole day and without sleep the whole night by focusing on thinking; that was not beneficial and it is better to spend the time learning” (15.31). That Confucius did not support revolutionary changes and instead advocated evolutionary progress is evident in his assertion that he “transmits but does not make; trusts in and loves antiquity” (7.1).

The “antiquity” in question is the Zhou dynasty in ancient China that was judged by Confucius to possess “the highest excellence of all” (8.20, also see 17.5). Declaring that he “follows the Zhou dynasty” (3.14), Confucius regarded the Zhou tradition as worthy of emulation. But it should be noted that what Confucius valued is not the historical tradition that has been passed down through the generations but the normative tradition or *dao* (Way). Confucius encouraged all to “learn in order to reach that Way” (19.7) and “be firmly committed to love learning, hold fast to the good Way till death” (8.13). The Way is the Way of heaven that embodies “a vision of human excellence” (Cua, 1989) and “guiding discourse” for all (Hansen, 1989). The Way is preserved and manifested in various forms such as traditional texts, cultural resources and the exemplary attitudes and conduct of sage-kings (Tan, 2013).

It is important to note that the Zhou dynasty is lauded by Confucius not for simply receiving and transmitting the beliefs, norms and ways of life of previous dynasties; rather, it is exalted for resourcefully adapting and adding to historical precedents in accordance with *dao* (Way). Such evolutionary changes were noted by Confucius who stated: “The Zhou dynasty builds on the normative behaviors of the Yin dynasty, and the abolitions and additions (made by the Zhou dynasty) can be known” (2.23). In the spirit of creative modifications, historical traditions should not be accepted unconditionally but should instead be (re)interpreted and appropriated through the lens of the Way. That the Way can – and should – be extended through human efforts shows that it is not monolithic, complete, fossilized and static. As Confucius put it, “It is human beings who are able to broaden the Way, not the Way that broadens human beings” (15.29). To broaden the Way is to attain and expand on the vision of human excellence from one’s cultural tradition (Tan, 2017). Confucius demonstrated the extension of the Way in his advice to judiciously select the praiseworthy elements from the past: “Follow the calendar of the Xia dynasty, ride on the carriage of the Yin dynasty, wear the ceremonial cap of the Zhou dynasty, and as for music, play the *shao* and *wu*” (15.11).

Context

The second defining feature of Confucius’ *in situ* creativity was his attention to context that revolved around particularity, contingencies, processes and harmonization. To broaden the Way, according to Confucius, is to live a life that adheres to *li* (normative behaviors). Conforming to *li* entails “learning and practicing what one has learnt from time to time” (1.1) in particular situations. Underlining the all-encompassing nature of *li*, Confucius exhorted all: “Do not look unless it is in accordance with *li*; do not listen unless it is in accordance with *li*; do not speak unless it is in accordance with *li*; do not move unless it is in accordance with *li*” (12.1). *Li* is a personal, inspirational application of the normative tradition through desirable values, attitudes, dispositions and conduct (Tan, 2013). Examples of *li* listed in the *Analects* include mundane activities such as one’s posture (10.12; 10.10; 10.24), greeting someone (3.7), and interacting with others (12.2). *Li* demands that one responds autonomously, appropriately and flexibly in all problem-situations. Creativity is essential for the exercise of *li* as the former empowers one to make sense of, devise and alter existing ideas and practices to new and challenging circumstances.

The fact that Confucius’ approach to creativity was situational implies that it was highly personalized and essentially moral. The personalized aspect of creativity was testified to in Confucius’ description of a *junzi* (noble or exemplary person) as one who is “not inflexible” (15.37; also see 1.8) and like “a vessel” (2.12). During Confucius’ time, a “vessel” is a receptacle used for specific ceremonial occasions. Unlike a vessel that is restricted to a pre-determined function, a *junzi* (re)acts inventively to ever changing and unexpected situations. A *junzi*, “in one’s dealings in the world, is not for or against anything; such a person goes with what is appropriate” (4.10). Exercising one’s discernment, discretion, versatility and enterprise, such a person “selects what is good and follows it” (7.28). Confucius exhibited “creative personalization” (Ames and Rosemont, 1998) by responding in varied ways to different people. A classic passage in the *Analects* narrated his contradictory answers to two students who asked him the same question on whether they should act upon hearing something. To Zilu, Confucius stopped him from taking action on the basis that his father and elder brothers were still alive. But to Ranyou, Confucius encouraged him to act immediately. Confucius’ patently oppositional answers puzzled another student who sought clarification. Confucius replied: “Ranyou is diffident, and so I urged him on. But Zilu has the energy of two, and so I reined him in” (11.22). This episode illustrates Confucius’ creative responses by tailoring his teaching to suit the diverse personality traits and needs of the learners.

Besides being highly personalized, Confucius’ understanding of creativity was also fundamentally moral (Tan, 2016a,b). At the heart of *li* is *ren* (humanity or benevolence); Confucius pointed out that *ren* is simply to “return to *li*” (12.1). Associated with *ren* are virtues such as *xiao* (filial piety), *shu* (empathy and reciprocity), *zhi* (wisdom), *yi* (rightness or appropriateness), *yong* (courage), *he* (harmony) (12.1, 17.6). *Ren*-centered creativity directs human beings to gradually and prospectively broaden the Way that connects the past to the present and future. An example is Confucius’ judgments on the prevailing practices concerning ceremonial cap and prostration:

The Master said, “A ceremonial cap of linen is prescribed by *li*. Nowadays, a silk cap is used instead. This is frugal and I follow the majority on this. To prostrate oneself before ascending the steps to the hall is prescribed by *li*. Nowadays, one prostrates oneself only after ascending the hall; this is arrogant. Although this goes against the majority, I prostrate myself before ascending.” (9.3)

On both occasions, Confucius was guided by ethical considerations. In the first case, he supported the substitution of linen with silk for the ceremonial cap on the basis of frugality. In the second instance, he refused to go along with the common practice to prostrate only after entering the hall because doing so showed a lack of reverence. Confucius’ deliberations were based on moral principles that show the intrinsic *ren*-driven attribute of creativity. Relating context to broadening the Way, Hall and Ames

(1987) maintained: “Each important cultural figure in each historical period not only embodies *tao* [Way] in a particular manner appropriate to his unique circumstances, but also, with the energy of his own original contribution, is able to set the dynamics of *tao* on a novel course” (p. 232).

Human Interdependence

The final distinctive feature of Confucius’ *in situ* creativity was interdependence. Combining creating and self-creativity (Ames, 2011), Confucius stressed agendas and activities that promote not only one’s own interests and needs but also the productivity and significance of shared relationships. The interdependence of self and others was encapsulated in Confucius’ contention that “in helping oneself to take a stand, one helps others to take their stand; in desiring to reach a goal, one helps others to reach their goal” (6.30). In Confucian parlance, “taking a stand” denotes performing one’s social roles through displaying normative behaviors and corresponding values and attitudes (Tan, 2013). The process of taking a stand involves, among others, observing *li* (12.1, 12.2), loving learning (1.14, 8.13), learning extensively (9.2) and synthesizing the old and the new (1.1). “Helping oneself to take a stand”, it follows, is to cultivate oneself through self-directed learning, authentic moral motivation and personal articulation. Believing that all human beings “are similar in their nature but differ as a result of their practice” (17.2), Confucius posited that everyone can become a *junzi* as long as one puts in effort to improve oneself (14.42). Using himself as an example, Confucius shared that he was set on learning at the age of fifteen and was finally able to “follow my heart-mind’s desires without overstepping the line [*li*]” (2.4) when he was seventy years old.

But helping oneself to take a stand goes hand in hand with helping others to take their stand. As Hall and Ames (1998) put it, “creativity requires that each participant in a relationship be continually in the process of creating the other” (p. 273). A *junzi* is marked by one’s desire to “cultivate oneself in order to bring peace to the multitude” (14.42) and “love others” (12.22). There was therefore an inherent social component to Confucius’ notion of creativity. It is impossible, as envisioned by Confucius, for one to develop oneself in isolation without participation in and contributing to social relationships. According to Confucius, creating and self-creativity are facilitated by *zhengming* (rectification of names) where one lives up to one’s social role, be it as a ruler, minister, father or son (12.11). Pointing out that “when names are not correct, what is said will not be used effectively” (13.3), Confucius reminds us that one’s name conveys normative and communal implications and value. Creativity is relevant to *zhengming* since one cannot be a good ruler, minister, father or son by performing one’s role mechanically or thoughtlessly. Instead, what makes one a good ruler, minister, father or son in the eyes of others are conscious, purposeful and motivational attempts to meet the expectations that commensurate with one’s name in specific contexts.

Central to the affirmation and enhancement of shared relationships is the virtue of *he* (harmony or harmonization). Harmony is prized for “making the Way of the Former Kings beautiful, and was a guiding standard in all things great and small” (1.12). Harmony is attained when human beings not only enjoy inner peace but also co-exist with and build up one another in accordance with *li*. Confucius gave details to harmony in the following passage:

The Master said, “Little ones, why do none of you study the Songs? The Songs can give you inspiration, observation skill, ability to live with others, and means to express grievances. The Songs enable you to serve your father at home and your lord in public. You will learn broadly about the names of birds, beasts, plants and trees” (17.9).

Starting with oneself, studying poetry develops one’s imagination and moral cognizance through looking and listening (“inspiration”, “observation skills”, “learn broadly about the names of birds” etc.), speaking (“means to express grievances”), and moving (“ability to live with others”, “serving your father at home” etc.). The attainment of inner peace is complemented by external harmony where one lives amicably and collaboratively with other members of society (“ability to live with others” etc.) and nature (“learn broadly about the names of birds, beasts, plants and trees”). Anchored on harmony, one enriches and fortifies oneself through an ever-expanding circle of human relatedness (Tu, 1985). An analogy is four concentric circles, with moral self-cultivation in the innermost circle, followed by circles representing one’s home (parents and siblings), one’s community (one’s peers, juniors and elders) and finally the world (general society) (Tan, 2013). The interdependent aspect of Confucius’ creativity explains why he valued an attitude of open-mindedness, humility and mutual learning. He articulated, “When walking with two other persons, I am bound to find a teacher among them: I choose to follow the good person, and correct myself when I am with a person who is not good” (7.22).

Conclusion

This entry maintained that Confucius’ *in situ* creativity is not a break from the past but grounded in the vision of human excellence that originates from one’s culture. Rather than underscoring individual efforts and interests, the Confucian notion of creativity presented shines the spotlight on constitutive relationships and role ethics. As a “conservative innovator” (Tan, 2015), Confucius preserved and extended the normative tradition by creatively adapting it to episodic events and infusing it with moral and social significance. The continuation and furtherance of the Way is pivoted on an original and flexible appropriation of symbolic resources

for particular problem-situations. It is pertinent that Confucius ingeniously (re)defined well-known terms in ancient China such as *li* and *junzi* in his quest to bring to the fore the Way (Tan, 2017). He enlarged the meaning of *li* beyond the traditional meaning of ritual propriety to include all normative behaviors that are supported by corresponding values, attitudes and dispositions. In like fashion, he re-interprets the term *junzi* from the original meaning of an aristocrat to an educational ideal that is achievable by all. The Confucian conception of creativity as delineated in this entry is incongruent with perceptions of Confucianism and Confucian education that neglect, undermine and imperil the development of creativity. A dominant Confucian tradition in East Asia is one that brings to mind authoritarianism, unquestioned obedience, the maintenance of status quo, rote memorization, indoctrination and suppression of individuality (Kim, 2007). Offering an alternative reading of Confucianism, this entry has presented Confucius' *in situ* creativity – one that celebrates normative tradition, context and human interdependence.

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Consensual Assessment[☆]

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Introduction

Over time, the field of creativity research has seen a gradual shift away from an almost exclusive emphasis on the creative person towards a more balanced inquiry that centers both on individual difference issues and questions about the nature of creative products and the conditions that facilitate the creation of those products. The consensual assessment technique (CAT) allows for the assessment of the relative creativity of products and is based on the assumption that a panel of independent raters, persons who have not had the opportunity to confer with one another and who have not been trained by the researcher, are best able to make such judgments. Over 40 years of research have clearly established that product creativity can be reliably and validly assessed based upon on the consensus of experts. Although creativity in a product may be difficult to characterize in terms of specific features, it is something that people can recognize and agree upon when they see it.

The CAT has been successfully used in hundreds of between-subjects designs focused on the question of whether some conditions are more conducive to creativity than others. The conditions experimentally compared have been both naturally occurring (as in field studies conducted in industrial/organizational studies) or artificially created and manipulated by an experimenter. Study participants are sometimes drawn from a single, underlying population or they might represent persons coming from a variety of different backgrounds, cultures, etc. Within-subjects designs can also incorporate the CAT to explore whether some conditions are especially conducive to or detrimental to creativity. In addition, the CAT can be used to assess the relative creativity of products produced by individuals who have submitted their work to professional competitions (e.g., graphic design or marketing) or to compare product ratings made by different groups of judges: experts vs. novices, supervisors vs. employees, teachers vs student, children vs. adults, judges in one culture vs. judges in another culture.

The Unique Assessment Concerns of Creativity Researchers

A variety of personality checklists have often been used to identify highly creative persons as well as personality traits or cognitive styles associated with creative performance. Other creativity indices have focused on behavioral factors. These behavioral assessments, such as the Torrance Test of Creative Thinking (TTCT; [Torrance, 1974](#)) have typically built on Guilford's theory of divergent thinking ([Guilford, 1976](#)) and elicit oral, written, and drawn (nonverbal) responses from participants.

But what does it mean when someone scores high (or low) on these creativity tests? Should high scorers be considered "creative persons?" Many creativity measures might accurately tap one or more creative abilities or predispositions, but it is most unlikely that a single test could be developed that would capture the full range of creativity components. Also troublesome is the fact that a variety of social and environmental factors have been found to influence test results. Study participants' scores can be improved simply by

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telling them that creative responses will be valued, and many investigations have shown variability in creativity test scores under different testing conditions and time constraints.

Even if contextual and situational factors could be controlled for, the construct validity of many of these tests has also been seriously questioned, as has the convergent validity of different test procedures considered together. This validity issue is especially problematic given the fact that many of the leading creativity tests have been validated against one another. Moreover, some tests equate divergent thinking and even fluency (number of responses) with creativity; and other scoring procedures, while purported to be objective, are based upon the test constructor's own intuitive notion of what is creative.

Early Applications of Consensual Assessment

Mindful of these and other difficulties inherent in the creativity testing process, a growing number of researchers have become convinced that creativity judgments can ultimately only be subjective. Rather than attempting to objectify the creativity rating process, these investigators rely on the consensual assessment of persons or products. In fact, the subjective assessment process has a long history. As far back as 1870, researchers were relying on biographical dictionaries to select outstanding literary figures and scientists. Early research done by Cox (1926) drew a pool of geniuses for a personality study from Cattell's list of the 1000 most eminent individuals in history. More recently, Simonton developed a measure of creativity based on frequency of citation in histories, anthologies, and biographical dictionaries.

Other investigations have relied on the judgments of a select group of experts to assess the creativity of particular individuals. For example, an expert-nomination procedure was carried out by MacKinnon et al. for a series of studies in the 1960s at the Institute for Personality Assessment and Research in Berkeley, California (Mackinnon, 1964). Helson and Crutchfield gathered mathematicians' nominations for the most highly creative women in their field (1970); and Barron (1966) requested that three professors of English and one editor of a literary review suggest names of creative writers.

Shifting their focus away from the creativity of persons, some researchers have instead asked raters to make assessments of the creativity of particular *products*. In the majority of investigations of this type, the researcher has either presented judges with her own definition of creativity for them to apply or has trained them beforehand to agree with one another. While such methodologies may successfully avoid many of the problems inherent in paper-and-pencil creativity tests, the fact that judges have been carefully instructed in the rating process calls into question both the claim of judge-based subjectivity and the meaning of interjudge reliability. Rather than impose specific definitions of creativity or related dimensions, researchers would be better served if they allowed judges to make their own, independent product assessments. In this way, creativity assessments will more closely mirror real-world assessments.

Getzels and Csikszentmihalyi (1976) did just this when they requested that four different groups of judges (two expert and two nonexpert) use their own individual criteria when rating drawings on originality, craftsmanship, and overall aesthetic value. Soon thereafter, Sobel and Rothenberg also utilized this subjective assessment technique. Investigations such as these managed to overcome much of the criticism levied against the earliest applications of consensual assessment to product creativity, yet a variety of difficulties still remained. First, many of the procedures failed to differentiate between the creativity of products and other related constructs such as technical correctness or aesthetic appeal. Further, most of these early researchers did not clearly state an operational definition of creativity, even when they had trained their judges to recognize specific creativity criteria in products. Nearly all contemporary definitions of creativity are conceptual rather than operational. They were never intended to be translated into actual assessment criteria.

Systematizing the Consensual Assessment Technique in Creativity Research

The consensual assessment of creativity was first formalized and systematized by Amabile's work in the social psychology of creativity, beginning in the late 1970s. When this program of investigation was started, existing creativity measurement tools, including available subjective assessment methodologies, could not meet the unique research requirements of investigators interested in the social psychology of creativity. The majority of available assessment techniques viewed creativity as an enduring personality trait. Most paper-and-pencil measures had been specifically constructed to maximize individual differences. Even existing subjective assessment methods relied on products or entire bodies of work that depended heavily on an individual's level of expertise. Prior methods had been constructed to do exactly what social psychologists interested in the impact of the social environment on behavior are trying to avoid.

In social psychological studies, individual difference effects must be minimized. Creative task performance must not depend heavily on participants' specialized skills. Prior to Amabile's work, the literature had not identified a methodology that could de-emphasize individual differences between subjects. In addition, researchers had not agreed upon and consistently employed an operational definition of creativity. Amabile's first step was to adopt two complementary definitions of creativity: an underlying conceptual definition to use in building a theoretical formulation of the creative process and an operational definition to apply in empirical research (Amabile, 1982).

Amabile's conceptual definition of creativity rests on the premise that a product or idea is creative to the extent that it is a novel and appropriate response to a heuristic task. This definition is similar to a number of others that came before it. Despite the implicit emphasis on the person in creativity assessment, most explicit definitions have used the creative product as the distinguishing sign of creativity. Indeed, the criteria of product novelty and appropriateness have long been seen as the hallmarks of creativity by a number of theorists.

The CAT is grounded in the original operational definition that Amabile developed: a product or response is creative to the extent that appropriate observers agree it is creative. Appropriate observers are those familiar with the domain in which the product was created or the response articulated. Importantly, this consensual definition is based on the creative product rather than the creative process. In fact, the majority of creativity assessment techniques require that study participants produce something – a list of ideas, a series of pictures, or the like. What sets this methodology apart from the rest is that, rather than responding to a series of pre-determined items or questions, study participants produce an actual product such as a poem, a collage, or a story. Perhaps the most important feature of this consensual definition is its reliance on subjective criteria. In this way, it overcomes the difficulty of attempting to specify ‘ultimate’ objective criteria for identifying products as creative. Indeed, it may be impossible to articulate such ultimate criteria. Judgments of creativity are necessarily subjective, relative and bounded by time and place. Creativity should not be seen as residing inside the artist or scientist or with judges representing a particular field of expertise. Nor does creativity reside in a particular culture or time period. Creativity is neither universal nor stagnant and must be seen as the result of a complex interaction between the three components of creator, domain, and field.

Amabile et al. have attempted to capture the essential characteristics of the conceptual and operational definitions of creativity in the CAT as used in experimental studies of creativity. First, study participants are presented with tasks that leave room for considerable flexibility and novelty of response (open-ended, heuristic tasks). Second, these are tasks for which the range of appropriate responses has been clearly identified in study participants’ instructions. Finally, in employing the CAT, researchers do not impose on raters their own specific views of what is creative or allow raters to influence each other; rather, raters work independently and are guided by their individual subjective conceptions about creativity.

Refining the CAT

The CAT rests on two important assumptions. First is the assumption that it is possible to obtain reliable judgments of product creativity, given an appropriate group of judges. In other words, although creativity in a product may be difficult to characterize in terms of specific features, it is something that people can recognize when they see it. Furthermore, people familiar with such products can agree with one another on this perception. A second assumption is that there are degrees of creativity such that observers can say, at an acceptable level of agreement, that some products are more or less creative than others.

Procedural Requirements

When utilizing the CAT, a number of requirements must be met. First, judges should all have had some experience (and roughly equivalent experience) with the domain in question. When Amabile et al. were first developing the CAT, they relied on the notion of ‘expert’ to describe an appropriate body of raters. Over the years, this view has come to be tempered. Basically, the method requires that all those rating products be familiar enough with the domain to have developed, over a period of time, some implicit criteria for creativity, technical goodness, and so on. For example, when asked to rate the creativity of paper collages, both children and adults from a variety of backgrounds have produced highly reliable assessments. When dealing with a more specialized and esoteric field, such as physics or computer programming, however, the range of ‘experts’ would certainly have to be considerably narrower. In either case, it is the judges’ familiarity with the domain that is important, not the fact that they, themselves, may have produced work rated as highly creative.

A second requirement is that the judges must make their assessments independently. They are not trained by the experimenter to agree with one another; are given no specific criteria for judging creativity; and are not allowed to confer in their assessments.

Third, judges should be instructed to rate the products relative to one another, rather than against some absolute standards they might hold. This is important because, for most studies, the levels of creativity produced by “ordinary” study participants will be very low in comparison with the greatest works ever produced in that domain.

Fourth, each judge should view the products in a different random order so as to avoid methodological artifacts.

Finally, if this technique is to be used to evaluate performance on a task to which it has not been applied in the past, judges should be asked to rate the products on other dimensions in addition to creativity. Minimally, they should make ratings of technical aspects of the work, and if appropriate, its aesthetic appeal as well. These additional assessments make it possible to examine the degree of relatedness or independence of these dimensions in subjective judgments of the products in question.

Once the judgments are obtained, ratings on each dimension should be analyzed for interjudge reliability. In addition, if several subjective dimensions of judgment have been obtained, these should be entered into a factor analysis to determine the degree of independence (discriminant validity) between creativity and the other dimensions investigated. Finally, if the products lend themselves to a straightforward identification of specific objective features, these features may be assessed and correlated with creativity judgments. Prior studies have identified some physical features of collages and some verbal features of stories that correlate with creativity judgments.

Reliability

Given the consensual definition of creativity, the most important criterion for the results of this assessment procedure is that the product ratings be reliable. In order to compute reliability, Amabile originally utilized the Spearman–Brown prediction formula

that is based on the number of judges (n) and the mean interjudge correlation (r). Because this technique yields results highly similar to both Cronbach's coefficient alpha and Intraclass Correlation (ICC), in recent years most researchers employing the CAT have relied on either Cronbach's alpha or ICC as their measure of interrater agreement. In fact, the Average Measures Consistency Formulation for ICC, where the same group of raters rate all the products in question, yields exactly the same value as does Chronbach's. In most instances, a reliability figure of 0.70 or higher can be considered evidence of an acceptable level of agreement between judges. Once such a level is reached, it is then appropriate to compute a sum (or an average) across all ratings given each product. These sums (or averages) then constitute the unit of analysis for further computations.

By definition, interjudge reliability in this method is equivalent to construct validity: if appropriate judges independently agree that a given product is highly creative, then it can and must be accepted as such. In addition, it should be possible to separate subjective judgments of product creativity from judgments of technical goodness and aesthetic appeal. Within some domains, it may be difficult to obtain ratings of product creativity that are not highly positively correlated with judges' assessments of product technical goodness or aesthetic appeal. Yet it is essential to demonstrate that it is at least possible to separate these dimensions, otherwise the discriminant validity of the measure would be in doubt. In other words, judges might be rating a product as 'creative' merely because they like it or believe that it is technically well-done.

Supporting Data

In the program of research carried out by Amabile et al. over the last 40 years, numerous studies have demonstrated that the CAT does, in fact, yield reliable measurements appropriate for social psychological studies of creativity. In studies targeting the performance of highly trained and experienced individuals, professionals and/or graduate students often serve as the "expert" judges. But in investigations focused on the creativity of students or enlisting a cross-section of untrained adults, classroom teachers or college students have also been recruited. Across domains, ten or so judges have typically been employed. Virtually without exception, raters have yielded highly reliable assessments of creativity.

Equally important as interrater reliability is the requirement that judges' assessments of certain additional product dimensions do not correlate highly with their ratings of creativity. Here too the results have been encouraging. In keeping with most theorists' conceptions of creativity, ratings of novelty and originality have typically been highly related to ratings of creativity, while ratings of various aspects of product technical goodness have not usually been significantly correlated with creativity assessments.

The most widely used measure of creativity employed in conjunction with the CAT asks study participants to create a paper collage. Amabile et al. have also incorporated a wide variety of other creativity tasks include the completion of five-line American haiku poems or the construction of free-form poems, the writing of essays and descriptive paragraphs, the construction of captions for cartoons, and telling a story to accompany an open-ended picture book without words. Each of these verbal tasks has also yielded highly reliable creativity assessments. Whether they are poets rating haikus, elementary school teachers rating children's stories or graduate students rating cartoon captions, judges show consistently high interrater agreement.

In addition to measuring artistic and verbal performance, Amabile et al. have also employed some creative problem-solving tasks. One assessment procedure calls for the construction of a geometric design on a computer screen. Another activity requires that young subjects fill in the outline of a geometric shape with colored pieces of felt. Problem-solving tasks appropriate for adults include the construction of computer programs, the building of structures from ordinary materials, and the generation of survival ideas, ideas for dealing with a variety of social situations, and ideas for high-tech products and business solutions. Although none of these techniques has been tested to the same extent as the collage-making or many of the earlier verbal creativity tasks, it is encouraging that judges have rated products produced by children and adults with high levels of reliability.

Recent work by Hennessey et al. investigated whether the CAT would also produce valid and reliable creativity ratings in non-Western cultural settings. Specifically, one series of five studies recruited school teachers from the United States, Saudi Arabia, China, Turkey, and South Korea to assess collages and stories created by children living in their local area. All children had been randomly assigned to expected reward or no-reward (control) conditions and were given identical task instructions and materials with which to work. Results confirmed that across all five cultural contexts, ratings of product creativity showed high levels of interjudge agreement. This suggests that the CAT is especially useful for cross-cultural investigations. Rather than impose a measure and scoring criteria originally developed for use in the West, the CAT allows for the subjective assessment of products by judges who come from the same cultural context as the study participants who produced the products (see [Hennessey et al. \(2008\)](#)).

Clearly, the CAT has wide-range application. It has been successfully employed with both child and adult participants and allows for the assessment of creativity in a number of different domains. Over the years, participant populations have been expanded beyond the original pool of undergraduates and elementary school children, demonstrating that the creativity of professional artists, professional art students, computer programming students, student poets, and employees of high-tech or graphic design companies can also be reliably assessed.

Taking a Closer Look

The CAT has consistently been shown to yield reliable measures of product creativity in a variety of contexts, but what is it exactly that judges are doing when they set out to make their ratings? Are they assessing only the completed product or are they also making assumptions about the process that went into producing that product? Can judges be expected to reliably assess features of the

creative process? Hennessey (1994) conducted a series of four studies with these questions in mind. Reliability was high and raters who had been asked to make assessments of process had no more difficulty than did raters assessing finished products. A strong and positive relation was also found between ratings of product creativity and ratings of the creativity of the processes that went into completing those finished products. And similar strong and positive correlations were found between ratings of the technical goodness of finished products and ratings of the technical goodness of the processes that lead to the completion of those products.

Another question: when asked to assess product creativity, are raters considering only the final product? Or do they also take into account other factors – factors such as information about the circumstances under which a product was produced or the characteristics of the creator? In investigations employing the CAT, judges are typically given very little information about the persons who have made the products they are to rate. Implicit in this procedure is the assumption that creativity is a unitary construct independent of factors such as background or experience of the creator.

The last of Hennessey's four investigations was intended as a preliminary exploration of the impact of artist age information on judges' creativity assessments. One group of undergraduates judged collages made by children and adults after receiving accurate information about the age of the artists. A second group rated the same collages after receiving false, reversed information as to the age of the artists. Finally, a third group of undergraduates made their ratings without being given any information as to the age of the artists. Reliabilities were highly acceptable for all three of the judgment conditions, and age information was found to have a significant effect. The highest creativity ratings were given to adults' collages that had been falsely labeled as children's products. The lowest creativity ratings were given by judges who had received no age information to collages that had been produced by children. Overall, it was found that those raters receiving age information about the artists, whether accurate or reversed, gave products higher ratings of creativity than did raters for whom no age information was available. Within age information groups, no significant differences emerged between judges' creativity ratings of children's and adults' collages.

Some of the judges polled reported that they had considered artists' ages when making their product assessments. Some other respondents mentioned "fighting" against the tendency to take artist age into consideration. Contrary to expectation, it was the mere availability of age information and not the specific adult or child label that affected raters' judgments. Whether raters were given an accurate or a reversed age label, they judged children's collages to be higher in creativity than did raters given no age information. This finding suggests that creativity theorists and other researchers wishing to employ the CAT must be certain to note whether age information has been made available, either purposefully or unintentionally, to judges. Similarly, careful assessments should be conducted to determine whether raters have made any age inferences on their own.

Does knowing a subject's identity inject bias into judges' creativity ratings? This question is particularly pertinent to field studies of creativity within the realm of organizational behavior, as researchers frequently elicit supervisory ratings of subordinates' creative behavior. This procedure necessitates that supervisors know the identity of the individuals who have produced the products or generated the ideas they are rating. While these studies typically control for workers' gender, age, organizational tenure, and other demographic variables that could impact creativity ratings, research has yet to determine the extent to which supervisors' attitudes, affective states or biases might impact their ratings in significant ways. This issue is of particular concern because most organizational studies rely on the ratings of only a single supervisor, violating a central tenet of the CAT. However, a study by Baer and Oldham (2006) did find that independent ratings by two supervisors correlated highly. Of course, it is possible that both supervisors were subject to the same biasing forces. Thus, ratings of an individual's work by people who know that individual must always be regarded with caution.

Another related issue is whether individuals can make reliable ratings of the creativity of their own work. Researchers have typically found moderate correlations between creativity self-assessments and mean ratings made by others, although self-ratings often show a positivity bias. For example, in a study by Moneta et al. (2010), workers' monthly self-assessments of their creative contributions to a project correlated moderately and significantly with independent ratings made by coworkers and supervisors. However, the mean self-ratings were higher than either the mean coworker ratings or mean supervisory ratings. Other researchers have found moderate correlations between self-ratings and peer-ratings. Indeed, a meta-analysis conducted by Heidemeier and Moser (2009) yielded an overall correlation of 0.22 between self and supervisory performance ratings. In sum, the literature suggests that self-ratings of creativity do relate to ratings made by external observers, but may be biased toward positivity.

A variety of papers have carefully explored these and other issues concerning the question of who should be considered an appropriate judge. In one study, parents and teachers were found to be equally accurate at recognizing the creativity of children's ideas. But other investigators found that young children's judgments about art were considerably different from those offered by older children. Runco et al. asked college students to each produce three three-dimensional artworks that were then rated by the students themselves, a group of their peers, and three professional artists. Analyses revealed that the student participants saw significant differences in the creativity of their own three art projects. Similar differences also were reflected in the peer ratings of the artwork. The assessments made by the professional artists, however, failed to reflect significant differences in creativity between products. Thus, vast differences in level of expertise between study participants and judges may influence creativity judgments.

Dollinger and Shafran (2005) reopened the question of whether nonexpert judges might reliably rate the creativity of drawings made by a sample of nonprofessional artists. In an interesting modification of the CAT, Dollinger and Shafran calibrated nonexpert judges' artistic creativity ratings by exposing them to 16 prototype drawings and corresponding ratings made by expert judges in a prior experiment. Subsequent to the calibration, the mean correlation between expert and nonexpert ratings for a second set of products was 0.91.

Taken together, these results suggest that some clarification or modifications be made to the CAT specification about what qualifies as an appropriate level of judge expertise. When rating products produced by either nonprofessional or professional

individuals, appropriate judges should be defined as persons whose expertise matches or exceeds the expertise of those individuals who created the products. In the case of products produced by nonprofessionals, if researchers desire nonexpert judges' ratings to correspond to ratings made by expert judges, researchers may use a calibration technique. Finally, if creativity assessment procedures require raters to have familiarity with the entire body of a given person's work – as is often the case in field research – the most appropriate judges will be those with the greatest knowledge of the individual's performance and output. Importantly, as cautioned earlier, future research in this area should consider the extent to which knowledge about a creator's identity might bias the validity of such ratings.

Recent Developments

Over the years, the CAT methodology has been extended to a variety of tasks in a variety of domains, and the diversity of participant populations and rater populations being studied is also constantly growing. Perhaps the most prolific expansion of the CAT in recent decades has occurred in the organizational domain. In field studies designed to investigate the creative performance of professionals, supervisors and/or coworkers are frequently called upon to serve as raters. As noted earlier, the majority of organizational creativity studies rely on the ratings of a single supervisor per study participant. This dependence on supervisor ratings draws on a decades-long tradition in the organizational literature of using such assessments to obtain quantitative measures of an employee's performance. Although the traditional CAT involves multiple judges rating the creativity of products using a single-item scale ("creativity"), the organizational domain has adapted the CAT to involve a single supervisor who rates several employees on a multi-item scale (e.g., "Searches out new technologies, processes, techniques, and/or product ideas"; "Generates creative ideas").

Recent advancements in the organizational behavior literature call into question the validity of supervisory creativity assessments. Mueller et al. (2018) showed that employees in a gate-keeping role, a role with responsibility for determining which ideas should be retained within a community, tended to rate the same idea as less creative if it had low (relative to high) social approval (e.g., Facebook likes, investor interest). Critically, those who were not in a gate-keeping role did not view social approval cues as relevant to creativity assessments. Further, social approval cues are negative and unreliable indicators of idea novelty and usefulness respectively. As supervisors often serve as gate-keepers of their subordinates' creative ideas, those in a supervisory role may exhibit a bias against creativity and so rate employees as having *lower* creativity if they generate highly creative ideas that lack social approval.

To overcome the limitations of using supervisor ratings to assess employee creativity, some organizational research has employed peer ratings of creativity – requiring every member of a team to independently rate the performance of every other member. This method appears particularly promising, as it allows researchers to assess inter-judge reliability. Yet other work in the organizational domain adheres more closely to the original CAT methodology by employing a set of independent judges to rate a specific idea (or set of ideas) developed by an employee. This practice allows for the calculation of inter-rater reliability and also diminishes the likelihood that the ratings merely reflect personal characteristics of the employee in question (e.g., age).

One additional arena of organizational creativity research that now frequently employs the CAT is the research on group creativity. Since the 1999 publication of the initial version of this encyclopedia, the investigation of group creativity has blossomed into a distinct, multifaceted, and highly prolific field of inquiry. Early brainstorming studies in the laboratory typically employed the CAT, requiring three or more expert raters to judge the originality of each idea produced by a group. The developing body of group creativity field research – like field research on individual-level creativity – has measured creativity in a variety of ways. Some field studies have employed a single rater to assess a specific product. At other times, group creativity research has employed multiple raters assessing either a single group product or the holistic creativity of a group. This CAT protocol allows for the calculation of reliability estimates, and is thus preferable to employing single judges.

Conclusions

Clearly, the CAT has been a great boon to many creativity researchers. It has broad application, is founded on a clear operational definition, and can be adapted to suit a wide variety of research situations. Moreover, with its similarity to real-world creativity judgments, the CAT enjoys a high degree of ecological validity. Despite these advantages, the CAT should not be considered an ultimate and universally useful means of creativity assessment. Indeed, this assessment methodology has some specific limitations. If time concerns are paramount, this approach is decidedly impractical. Choosing an appropriate task as well as an appropriate body of judges can be extremely time-consuming, as can the assessment of products and the necessary statistical data analyses. However, a number of creativity researchers continue to believe that the benefits of the CAT outweigh its costs; and recently, Kaufman et al. successfully experimented with a modified CAT technique that reduced time demands yet still yielded reliable assessments.

Perhaps the greatest strength of the CAT rests in the flexibility it affords to creativity researchers. First, the CAT can be used to obtain reliable assessments of the relative creativity (technical goodness, aesthetic appeal, etc.) of products made by a variety of individuals. Second, the CAT can be expanded to new participant populations, new performance domains, and new tasks that are quite different from those originally envisioned. In mimicking the way in which creativity is judged every day in the arts, the sciences, and the professions, the CAT helps bring creativity from the realm of the mysterious and the mystical, into the realm of the under-stood and the accessible.

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Contrarianism[☆]

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Glossary

Contrarianism Intentionally doing what other people are not doing. The term was adapted from economics and has become recognized as a useful way to describe a popular tactic for insuring originality in many creative endeavors, even outside of economics.

Creativity Original and useful or effective behavior, solutions, or insights. The usefulness criterion implies that contrarianism is not sufficient for creativity; contrarianism only guarantees originality.

Dark side of creativity Original solutions and inventions used in immoral or unethical ways.

Discretion Discretion is the better part of valor—and the same holds true for creativity. Many decisions are involved with the expression of creativity so the creator is exercising discretion about what problems to solve, how original to be, and so on.

Misplaced investments Occurs when a contrarian tactic is used, but the person is not investing enough time and energy into the topic or problem itself. Time invested into being different is often time away from the focused work and persistence that is necessary for creative breakthroughs.

Oppositional thinking A proclivity towards unconventional cognition. It leads persons to do what others are not, but it is not a conscious decision and is therefore not strategic nor related to intentional creativity.

Postconventional contrarianism The recognition of rules and conventions, but maintaining the tendency to make decisions for one's self. It may involve exercising discretion before acting in a contrarian fashion. It may also be viewed as discretionary originality.

Introduction

Mickey Mouse was created by Walt Disney in the late 1920s. Mickey was a result of collaboration; Disney worked with his brother Roy and Ub Iwerks. Walt could no longer use his 'star performer,' Oswald the Lucky Rabbit, because his previous distributor held the rights. Disney needed a new star, and Mickey was conceived.

Why a mouse? As a matter of fact Walt wanted a cat. He discussed this with Roy and Ub, and they decided on a mouse. That decision was implicitly contrarian because Disney and his collaborators wanted to do what no one else was doing. The character Krazy Kat was already widely known and a second feline would be unoriginal. For that reason Walt and his collaborators decided on a mouse – to be different and unique.

Interestingly, the original suggestion was to call the new character 'Mortimer,' but Walt's wife Lily decided that "Mickey" was more appropriate. The discussion between Walt and Lily, summarized in *Walt Disney: An American Original* (Thomas, 1994), can be described in terms of group dynamics and strategies, Walt being very contrarian, and Lily making sure that the new mouse would have a name which would sound right to the general public. "Mickey Mouse" has a nice ring to it; and like other creative names, labels, and titles, it is fitting in some aesthetic sense. This is true of all creative insights and ideas, not just names, labels, and titles. Creative work is original, but it is more than just original. It is original and fitting. Sometimes the latter is a matter of aesthetic fit. Originality and fit (or effectiveness) are the two requirements of the standard definition of creativity.

Rationale for Contrarianism

There is quite a bit of detail about contrarianism in the economic and investment theories of creativity (Rubenson, 1991; Rubenson & Runco, 1992, 1995; Runco, 1991; Sternberg & Lubart, 1991). The rationale for contrarianism is as follows: Originality is a critical

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aspect of creativity, and contrarianism has a high probability of leading to an original idea or behavior. It can be very practical because people can mindfully consider what others are doing and then do something different and original. If you just ask them to 'be original,' they may have some difficulty. There is often no clear-cut criterion with which they can actually judge their originality. But if you tell them to 'do what others are not doing,' they have something concrete to think about and to use in their efforts.

It is easy to be impressed by the contrarian tactic and see its value. There are several reasons. First, as just noted, it is operational and practical. It gives individuals something they can use when judging their ideas or behavior. Second, novel behaviors and actions are salient. For this reason the results of the contrarian effort are obvious. They often capture attention and may thus be rewarding. Third, it is an easy tactic to explain to others. Teachers, for example, can easily describe this tactic to their charges. A number of empirical projects have demonstrated how easily original thinking can be enhanced with contrarianism and other simple tactics.

Many biographies, autobiographies, and case studies mention contrarianism and tie it to creativity. The next section reviews example cases. The pros and cons of the contrarian tactics will then be discussed, as will limitations of case studies. As is true of all cases, they are merely illustrations, not evidence.

Individuals Who Have Used Contrarian Strategies

Many famous creative persons have used a contrarian tactic, in addition to Walt Disney. Gandhi was a contrarian, especially in his methods of passive resistance. These were fitting and original, given his beliefs and objectives. He found a way to both resist (which is in itself contrarian, at least *vis-à-vis* the British) and yet remain a passivist. Gandhi's passive resistance is paradoxical, being both resistance and passive, but this is true of many creative things. Passive resistance was paradoxical, contrarian, creative, and effective.

James Watson, who shared the Nobel Prize for his work on the structure of DNA, was contrarian as well. He collaborated with Francis Crick, and their competition with Linus Pauling was fierce (Watson, 1968). Sometimes competition requires contrarianism in that you do not want others to do what you are doing – or at least not until you have finished or established yourself.

In the medical research field Henry Heimlich (who developed the Heimlich maneuver) was long known as a maverick and nonconformist. Most recently he proposed curing patients with AIDS by giving them malaria. The *Los Angeles Times* claimed that "this is not the first time the 74-year-old Heimlich's headstrong approach to medicine has shocked, even outraged the Establishment." Heimlich was quoted as saying, "I don't do ordinary things. I don't follow all the rules if there's a better, faster way to do it" (Oct. 30, 1994: A30).

The *Los Angeles Times* also published an article, "Renegades Reinvent the Bicycle." Apparently the mountain bike – a modification of what *Britannica* called "the most efficient means yet devised to convert human energy into propulsion" – "came out of nowhere, a product of counterculture – invented by hippies, no less, a ragtag of pot-smokers and Haight-Ashbury drifters who barely got through high school." Note the term *counterculture*. This is one way of describing a group of contrarians.

A final example from the *Los Angeles Times* is Rock 'n' Roll. In a 1998 *Times* book review rock is called "a disagreement with established power – a refutation of authority's influence" (4/15/98, p. E6). Not that rock 'n' roll is the only rebellious kind of music. Duke Ellington was, for instance, quite the contrarian. Arnold Ludwig, author of *The Price of Greatness*, explained how "Knowingly or not, Ellington exploited traditional musical rules as inspiration for his jazz. If he learned that he was not supposed to use parallel fifths, he immediately would find a way to do so; if told that major sevenths must always rise, he would write a tune in which the line descended from the major seventh; and if the tritone was forbidden, he would find the earliest opportunity to use it and, to emphasize the point, would let it stand alone and exposed" (pp. 7–8).

The comment, "knowingly or not" is critical because by definition tactics and strategies are intentional. Unintentional contrarianism may best be viewed as *oppositional thinking*, which Ludwig (1995) defined as "the almost automatic tendency to adopt a contrary or opposite response" (pp. 7–8). Both contrarianism and oppositional thinking focus on what others are not doing, but the former is intentional, and thus tied to discretion, while the latter is unintentional and thus less likely to benefit creativity. Discretion will be discussed further below. But first several other examples of contrarianism should be mentioned.

Ludwig also described the work of Sigmund Freud. Certainly Freud's work was original, and yet it fit with his observations and with certain lines of medical theory. Freud was oppositional, and perhaps contrarian, in his efforts to do original work and in his nonconformity.

In the arts, Picasso described cubism as follows: "We were trying to move in a direction opposite to Impressionism." This is pure contrarianism, especially in its direction – namely, opposite to Impressionism. It is not just a reaction to others, and not just different, but *opposite*. In her chapter in the *Creativity Research Handbook* Stephanie Dudek argued that the Dadaists and Surrealists were "particularly determined to burn all bridges behind them." In this light, contrarianism breaks with tradition. That implies that *avant-garde* is inherently contrarian. As Dudek put it, *avant-garde* is "by definition art that is ahead of its time, that is shocking, disturbing, and therefore viewed as socially objectionable. Its specific aim is to undermine the existing order and to replace it with another. It attempts to do this by contradiction, challenge, confrontation, and self-assertion."

Turning from the visual arts, consider next Bruce Lee. He developed an original system of martial arts – Jeet Kune Do – but had to fight the established, traditional schools because they did not want to teach any such techniques outside of Asia. Bruce broke with tradition.

Howard Gruber described how the famed developmental psychologist Jean Piaget used several specific strategies. First, Piaget always thought with a pencil in his hand. This is a simple but useful tactic, given how fleeting creative insights can be. Second,

Piaget read outside his own field. Third, he did not read inside his own field. And last, he always had a target or “whipping boy.” The last of these implies working independently, imagining one’s critics, which is a kind of contrarianism. B. F. Skinner also suggested that scientists read outside their own field. This too is a kind of contrarianism, or at least increases the likelihood of it. Avoiding one’s own field is even more contrarian.

Dr Seuss, prolific author of children’s literature, broke rules on every page of every book. He made up his own words, used many an ungrammatical sentence, and defied the laws of physics in the actions of his characters. Gertrude Stein and e. e. cummings also come to mind; they too broke certain literary traditions.

Although instructive, these cases – Disney, Gandhi, Heimlich, Ellington, Freud, Picasso, Piaget, Skinner, Seuss, Stein, and Cummings – are famous creators. Generalizations from them are therefore questionable. As noted above, case studies are always only examples, not evidence.

Contrarianism in the Service of Creativity

Two distinctions will help to determine when contrarianism is in fact associated with creativity. First is the distinction between contrarianism and oppositional thinking. The former is intentional and the latter an unintentional tendency toward nonconformity and unconventionality. Similarly critical is the distinction between contrarianism that is intentionally used for the sake of creativity, and that which is used merely to insure originality and salience. Contrarianism does not guarantee creativity; it can have other outcomes or be directed to other objectives, including originality. But originality does not insure creativity; it is necessary but not sufficient. It follows that contrarianism for the sake of originality may lead only to deviance and not to creativity.

Salience is a possibility because contrarianism does lead to originality – the contrarian is different and unique – but it may just attract attention without actually introducing a truly creative idea or act. Original behaviors and actions are salient and thus do grab our attention. Creativity, on the other hand, probably is much more likely when the intention is creativity rather than mere salience or popularity. This is *contrarianism in the service of creativity*. When that is the intention, there is likely to be some fit, appropriateness, or effectiveness, as well as originality. Recall here that creativity requires both originality and effectiveness. Contrarianism only contributes to the former and can inhibit the latter.

Even contrarianism in the service of creativity has potential problems. First is what I once called *misplaced investments* (Runco, 1995). This occurs when the creator uses a contrarian tactic, but does so to the extent that he or she is investing time into being different and therefore not investing time and energy into the topic or problem itself. The investment is misplaced because time invested into being different is often time away from good focused work. This is especially problematic because quite a bit of research suggests that persistence and immersion is often a requirement for creative insights and breakthroughs.

A second potential problem is that contrarianism can lead the individual to break rules that should not be broken. It may be that the creator is reinforced for contrarianism because it leads to creative insights, but then fails to exercise discretion and applies the same tactic in areas where some conventionality should be respected. The proposals from Feldman, Gardner, and Csikszentmihalyi in 1999 and Gruber in 1993, that moral and humanitarian values should be clearly encouraged along with creativity, are relevant here. If contrarianism leads the individual to break the important rules that keep society running smoothly, we have an example of what Robert McLaren called *the Dark Side of Creativity*. Examples of this were given by Russell Eisenman and Richard Brower in the Special Issue of the *Creativity Research Journal* which was devoted to Creativity and Deviance. Brower provided long lists of eminent creators who spent time in jail. A more recent branch of this research used the term malevolent creativity. Even more recent empirical work by Jack Goncalo demonstrated how very simple decisions (e.g., about diet) that involve a disregard for rules have clear implications for when individuals have opportunities to act creatively.

Creativity as Postconventional Contrarianism

One useful way to think of contrarianism is as postconventional creativity. The term postconventional originated in developmental theories. It is a mature stage of development and follows the preconventional and conventional stages of development. A child in the first of these stages is unaware of rules, norms, and conventions, and in fact does not recognize the value of rules. His or her games are ever-changing; there are no stable rules to keep the child moving toward an objective. Moral judgments at this age are based on rewards and punishers rather than a sense of right and wrong. The child is, however, often quite creative in art and expression. Ask a group of preschoolers to draw pretty trees and you will get trees with pink, purple, and polka-dotted rather than green leaves. Preschool children pick their colors based on preference rather than convention. They are highly self-expressive, and that can be a very good thing for creative behavior.

Individuals in the conventional stage are well aware of rules – and in fact hold to very literal interpretations of them. They see the value of conventions. Conventional behavior allows them to fit in with one’s peer group, for instance, but sometimes the conventional individual puts too much effort into doing just that. The result is a tendency away from anything unconventional and original, which means that creativity is not possible. Conventional individuals respond to peer pressure and hate bending rules. This explains the fourth-grade slump in creativity, when many children become noticeably less original in their ideation. Conventionality also leads them to a literal use of language, and it certainly is apparent in their playing games (completely by the rules rather

than improvising as needed) and in their art. Children in this stage are likely to only draw trees that have green leaves. Not a polka dot in sight.

The third stage is postconventional. Here the individual is aware of rules, norms, and conventions, but make decisions for him- or herself rather than blindly conforming. Conventions are taken into account, but so is the immediate context. If asked to draw “what trees look like,” leaves may very well be green, but if asked to draw a beautiful tree, the leaves may include rainbow colors or whatever color is the individual’s favorite. This same capacity to recognize conventions but think for one’s self is exactly what was meant earlier by exercising discretion. With discretion, contrarianism will be used appropriately, in the service of creativity. Without discretion, contrarianism is blind and constant, probably oppositional rather than adaptive and effective. Contrarianism must be mindful to capture the originality and effectiveness that are both required for creativity.

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Corporate Creativity

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Corporate Creativity

A corporation is a company or group of people authorized to act as a single entity, and everybody interacts with corporations in many aspects of their lives. At the most transactional, individuals buy goods produced by a corporation. However, many people also interact with corporations more indirectly through consuming sporting events (e.g., corporate sponsors and advertising) and philanthropic activities. Corporations even hold political sway through financial donations and interest groups influencing policies or candidates. Interactions with these firms drive the economy and are critical in the society operates.

Outside of the business aspect, corporations have the ability to fundamentally alter the way people interact with each other and the environment. In large part, these changes are due to creativity and innovation that emerge from the corporate entity. In 1913, Ford introduced the assembly line, which reduced the production time of a car by nearly 80%. Further, the gains in efficiency while maintaining consistency ushered in a societal shift to more individuals being able to purchase cars. Assembly lines are not considered creative at this point due to the widespread adoption of the practice.

In a more recent example, Facebook is 18 years old at the time of this article. Not only has Facebook experienced financial success, but has registered 2.27 billion active users in less than two decades. There were competing social media sites at the time of Facebook's inception (e.g., MySpace), but the way in which users could interact through the platform was novel. It is hard to imagine a world today without connecting with individuals through some social media no matter the aspect of one's life (e.g., professional connections through LinkedIn). Innovative product development by corporations includes the Apple iPhone released in 2007 with their patented touchscreen. Within 2 years, Android released similar products, and the touchscreen is now synonymous with smartphones. When Apple first produced their phone, Nokia and Research In Motion (RIM) held sizable portions of the smartphone market share with limited touchscreen capabilities. Through products, process, or environments, corporate creativity is arguably a change agent in society.

This article offers a refinement for the definition of corporate creativity by separating organizational influences on individual creativity and the creative outputs of a corporate entity. To achieve this refinement, a three-part, multilevel framework of creativity strata is presented. Based on this framework, there is a discussion of how corporate creativity is influenced by top management teams, organizational resources and strategies, and organizational cultures and climates.

Creative Strata

Creativity is a complex, multifaceted construct. Rhodes' four Ps of creativity provided a useful framework for studying creativity. In this framework, creativity is examined in relation to the person, product, process, and press (i.e., environment). Further, researchers often attempt to explore the interplay between the facets (e.g., [Royston and Reiter-Palmon, 2017](#)). For example, how might creative personality factors operate through cognitive factors to influence creative output? The four P framework, however, is mainly focused on the individual level of creativity. Even when researchers examine organizational or environmental factors (creative press), the focus typically rests with individual and team creative outcomes (e.g., [Navarrese et al., 2014](#)). Less research has examined how creativity is conceptualized at more aggregated levels. The different facets of creativity also need to be considered in the level of creative analysis. This article will discuss creativity in terms of three strata: microstratum, mesostratum, and macrostratum.

At this point, a majority of creativity research falls within the microstratum. At this level, the unit analyzed is the individual. The goal of the research is to understand the factors that influence individual creativity whether that be personality factors, interactional phenomena, or environmental influences. At the mesostratum, the focus is the conglomeration of individuals into teams or multi-team systems. The focus is not on the individual production, but rather the creativity at a team or multiteam level.

This shift in level does not negate the four Ps framework. For example, researchers could examine how cultural influences or leadership practices influence a team's performance (creative press factors). Further, researchers could explore how multiple teams communicate in their production of a creative solution (creative process factors). In these examples, the unit of analysis shifts from the individual (i.e., microlevel) to a broader, team level (i.e., mesolevel). At the highest level, the macrostratum would encompass the conglomeration of teams and individuals into a corporation, or a system of corporations (e.g., an industry). Again, the four Ps framework is still useful at this level, but as with examining teams, the unit of analysis shifts to the corporation. For example, researchers might examine how the creativity and innovation emerging from Bayer or Pfizer impact the market with a novel drug.

Arguably there are additional levels researchers could explore that are above the corporation level. For example, researchers can examine movements and their creative outputs. An example would be the Cold War arms race between the Soviet Union and the United States, which spurred innovative technologies resulting in the advent of space travel. However, these broad concepts are outside the focus of this article. As the unit of analysis and outcomes become more abstract, previous frameworks do not need to be abandoned. We believe the facet frameworks such as the four Ps most likely transcend our strata.

Much like decisions regarding which statistic to use, this framework is predicated on the types of questions researchers are attempting to answer. If a researcher is only interested in the individual or team output, then the focus should be directed in those strata. However, if researchers are interested in corporate creativity, then the unit of analysis and outcomes must reflect this question. This framework is offered with the goal of advancing thought processes in exploring more aggregated creative efforts. It is this type of framework that will be used to discuss corporate creativity, which we believe is nested at the macrostratum.

Corporate Creativity Defined

Creativity is the production of an idea, solution, or product that is both novel and useful. For something to be creative it must have both component parts. This definition should transcend levels of creativity. Said another way, no matter it being an individual or corporation, creativity is built upon novelty and utility.

The research investigating organizational creativity provides multiple definitions for the construct. [Robinson and Stern \(1998\)](#) defined a company as creative "when its employees do something new and potentially useful without being shown or taught" (p. 11). This definition is more akin to the individual and team levels, and the definition does not best capture corporate creativity. Earlier, [Woodman et al. \(1993\)](#) offered a more holistic definition of corporate creativity: "The creation of a valuable, useful new product, service, idea, procedure or process by individuals working together in a complex social system" (p. 293). Returning to the framework presented here, we argue that corporate creativity would be the conglomeration of individual- and team-level factors. However, the work by [Woodman et al. \(1993\)](#) still appears to rest on the unit of analysis being the individual or team rather than the corporation. Turning to the innovation literature, [Damanpour and Evan \(1984\)](#) offered that corporate innovation was, "the implementation of an internally generated or borrowed idea [...] that was new to the organization at the time of adoption" (p. 393). In this last definition, the unit of analysis rests at the corporation, and the definition contains both novelty and utility.

Although nuanced, the definition of corporate creativity matters both for the core components and the level. To synthesize the work of [Woodman et al. \(1993\)](#) and [Damanpour and Evan \(1984\)](#), we offer that corporate creativity is the production of novel and useful products, processes, ideas, or solutions through the interactions between complex corporate structures. This definition captures the contextual environment, the unit of analysis (i.e., the corporation), and the component parts of creativity. This article will discuss top management teams, organizational strategies, and cultural factors that influence the creativity of the corporation.

Top Management Teams

Top management teams (TMTs) are the upper echelons of an organization (e.g., board of director members, chief officers, etc.). These individuals typically have the power to allocate resources, hire middle-management personnel, and determine project prioritization for the organization. Furthermore, the TMT is primarily responsible for setting the strategic vision. From this vision, the TMT builds structures and teams for employees to carry out the projects needed to achieve the vision. Moreover, the TMT can build norms for how work is completed and what the expectations are for completing the work. Due to the critical position and decision-making power, the TMT is a unique group of individuals who have the ability to influence the way in which creativity manifests in the organization. According to this top echelon perspective, the corporation ends up being a manifestation of the TMT ([Hambrick and Mason, 1984](#)). This ability to shape the nature of the corporation and the characteristics of this group may influence how creative the corporation can be. The characteristics of the group are typically researched in terms of the diversity of the TMT.

Diversity can be divided into demographic and functional diversity. Demographic diversity refers to those characteristics salient to others (e.g., age, race, gender, etc.). Functional diversity refers to the mix of specialization and expertise within a group ([Bunder-son and Sutcliffe, 2002](#)). Diversity has shown mixed results on the effects of team-level creativity. The major conclusion from teams' research is that demographic diversity may not be an effective facilitator of creativity within teams, but functional diversity may be a more effective influencer ([Reiter-Palmon, Mitchell and Royston, 2019](#)). Specifically for this article, the functional diversity of the TMT, measured by the business area the members came from, positively impacted firm creativity ([Yoon et al., 2016](#)).

One explanation for the increased effectiveness of functional diversity is that this type of diversity more easily highlights task conflict. When task conflict occurs, previous research indicates more creativity to emerge from the individual or team. However, task conflict can be difficult to separate from more relational conflict. Camelo-Ordaz et al. (2014) cautioned that the high correlations between relational and task conflict could mask the potential benefits of task conflict. Effective TMT teams need effective social processes to manage the conflict types to focus on task management (West and Anderson, 1996).

Diversity and any resulting conflict depends on whether the TMT values creativity. A company can have a multidisciplinary team that is full of individuals who want to maintain the status quo. In this case, the functional diversity may not lead to increases in company creativity. Further, individuals within the TMT may value more radical or less radical ideas, which would influence how radical the creativity emerging from the corporation is (West and Anderson, 1996).

TMT should be the factor of interest in corporate creativity rather than a single leader. Although corporations may have a singular, prominent leader, rarely are all decisions and resulting corporate creativity dependent on one person. For example, Elon Musk, Steve Jobs, and Warren Buffett are all individuals who are prominent figures within their respective firms; however, any innovation emerging from the corporation has input and efforts from a team of senior leaders. Examining singular leaders and their influence on creativity is out of the purview of this article.

The TMT is the group of individuals that truly drive the direction of a company. By having a high-functioning, interdisciplinary team that values creativity, the corporation's creativity may be heightened. At the microstratum level, we envision the effects of the TMT to manifest through organizational support for creativity or manager's support for creative behaviors. At the mesostratum, we argue the effects of the TMT to influence a firm's creativity through the vision, strategies, and structures put in place.

Organizational Resources and Strategies

A strategy is a plan with a clear aim or goal. For organizations, strategies are important for change initiatives, product development, and resource allocation. An organization's ability to find opportunities and develop strategies to exploit that opportunity is critical in maintaining competitive advantages.

Often firms are faced with paradoxes on how to best allocate resources for creative efforts. At the core, a successful business has products and processes that have generated stable and predictable delivery of goods as well as stable and predictable returns. This stability does not always allow creativity to emerge. Paradoxes are coexisting, ongoing tensions that have competing demands and are not typically solved with one-time solutions (Smith and Lewis, 2011). Specifically, firms can explore or exploit their resources in the pursuit of creative efforts. Explorations focus on longer-term investment in creative actions; whereas exploitations focus on the shorter-term and current processes to produce creative outcomes (Smith, 2014). Shorter-term resource allocation may result in more incremental creative outcomes; whereas longer-term resource investment may result in more radical creative outcomes. For example, a company that tweaks their production model through Lean processes may see a short-term bump in production through the creative retooling of the line; however, a company that invests in research and development may have a breakthrough, patented product that boosts the company well ahead of the competition.

In the leadership research, balancing the exploitation and exploration has been termed ambidextrous leadership (Zacher and Rosing, 2015). We argue that corporations can be ambidextrous as well. Part of this ambidextrous nature can come from leadership decision-making, but it can also be influenced by a culture of competition, strategic organizational actors (e.g., market research teams), or the vision produced by the TMT. This ambidexterity is a reflection of these organizational factors. Corporations that have highly competitive cultures and an aggressive TMT may focus heavier on short-term gains and incremental creativity (e.g., more reliance on exploitation). These actions can sometimes be seen when companies are taken over and then sold off piecemeal. Conversely, organizations may have an increased chance at more radical creativity by investing resources in longer-term projects, but the organizations may open themselves to potential competitive disadvantage by not innovating. As with many organizational constructs, the ambidexterity of an organization rests in that middle ground where successful companies must exploit and explore with resources allocated to creative efforts.

Cultural factors may also influence the exploitation/exploration paradox. Specifically, there appears to be a factor of speed, meaning short-term and long-term investments are relative to the rate at which the innovation is occurring. For example, a company that has a fail-fast mentality may be ambidextrous, but their longer-term exploration may be heightened by the rapid iterations of product development and testing. A more concrete example would be the development of the reusable rocket for space flight. SpaceX developed and successfully tested a reusable rocket in roughly 10 years. In the course of that decade, the company suffered multiple, public failures. However, the senior leadership, headed by Elon Musk, had instilled a culture of failing fast to increase the rate of creative production. Arguably, the entire process was a mix of exploiting the current processes for incremental creativity, and longer-term investment in technologies that resulted in a fairly radical innovation in rocket technology.

Besides the allocation of resources, there is a consideration of the availability of resources (i.e., the supply of inputs). Resource slack and constraints have been examined for how they influence individual and team creativity. Researchers found that the slack of resources can spur growth due to the increased investment a firm can make in innovative efforts; however, resource constraints can also force companies to adopt more creativity means to make the resources stretch further. In reality, it appears that the relationship between resources and creativity is curvilinear. There is most likely a Goldilocks zone where individual creativity is heightened and

either too much or too little resources are detrimental. Moving this above the individual, companies that are creative most likely have found a balance of resource allocation by being more ambidextrous.

One resource that is critical to corporate creativity is its creative capital, which is the pool of creative thinkers that generate ideas leading to valuable products (Florida and Goodnight, 2005). According to Florida, a third of the US population is comprised of the so-called creative class, which is made up of “professionals whose primary responsibilities include innovating, designing, and problem-solving” (Florida and Goodnight, 2005). Leveraging the pool of creative class individuals within a company is one challenge; the other strategy is how to select and retain that pool, or arsenal of talent, to ensure continued corporate creativity.

Human resource development (HRD) is a framework of building the talent pool within an organization. The strategies behind HRD include the practices that would align with the vision and TMT in pursuit of creativity and innovation. As Gibb and Waight (2005) argued, HRD is already concerned with individual factors that lead to increased creativity so it is time to link these strategies to larger organizational policies. In essence, it is time to link HRD practices to the larger macrolevel of analysis. In a review of the literature on improving creativity in organizational settings, Reiter-Palmon et al. (2019) discusses how organizations can select and train for creativity. Knowing that creativity can be something selected and trained for, HRD executives can logically expand on the previous work to move our discussion to a higher level. The strategies around setting the pipeline for creative individuals ensure there is lifeblood for corporate creativity. This pipeline is built through HRD strategies and can be determined by visions or goals set forth by the TMT. As was discussed with the diversity of TMTs, diversity of thought and experiences can vastly improve or hinder the level of corporate creativity. Those corporations who better develop their recruiting and selection processes to bring in innovative diversity are ensuring continued improvement.

Selection is only half of the human resource strategies. Training and development are important factors to increase the collective talent in the organization as well as retain individuals who are currently in the organization. Retaining the creative class appears to be a critical component to maintain corporate creativity. To this end, corporations that have more mature training and development programs may see increased yields in creative production. Again, it is not the aggregation of individuals selected, but it is the formation of an effective HRD strategy that dictates the recruitment, selection, and development of a workforce that can then influence the level of corporate creativity. Further, the HRD strategy should reflect the culture of the organization and the vision set forth by the TMT.

Organizational Culture and Climate

Organizational culture is the shared norms of the system that dictate behavior. Culture and climate are two of the most researched areas in the organizational creativity and innovation fields. Research has found increased creativity emerges from support for risk-taking, support from top management, challenging work assignments, autonomy, intellectual stimulation, and positive relationships with peers (for review, see Reiter-Palmon et al., 2019). A culture that provides members with meaningful, challenging work where they feel supported is critical for individual creativity. The culture of an organization can be determined largely by the TMT, where the leaders set forth expectations for what is and is not acceptable in the company. In this way, TMT can institutionalize creative efforts into the fabric of the company. Further, supportive peers and challenging work assignments can be determined by factors such as the HRD strategies the company has in place. Understanding your workforce and selecting appropriate individuals will help strengthen the culture and build the climate of safety and support needed for creativity. Further, the HRD can assist in providing challenging opportunities through programs such as institutionalized stretch assignments, job shadowing, job rotations, and high-potential programs. Together, a supportive TMT and appropriate HRD can create an organizational culture and climate that may lead to increased firm creativity.

Measuring Corporate Creativity

Corporate creativity has been discussed in terms of different strata. Specifically, this article focused on the corporate, or macrostratum of creativity. With this focus, the unit of analysis becomes the corporation rather than individual and team outputs. In this regard, the measurement approach must evolve. As it stands, the focus has been on how organizational factors influence individual outcomes. To truly measure corporate creativity, organizational-based outcomes must be adjusted.

As mentioned earlier, corporate creativity is not necessarily the aggregation of individual creativity. Yoon et al. (2016) provided an example of how corporate-level creativity might be measured by using externally based ratings of the company. Other measures might include impacts within the industry, or shifts in industry direction emerging from the firm. This measurement level is challenging and has not received the attention the individual level has. However, there is no need to discard the four Ps framework. For example, the processes an organization implements or develops to influence its creative outcomes can be examined (e.g., Damanpour and Evan, 1984).

A caution when measuring corporate-level creativity is that performance and creativity are not equated. Return on investment and corporate financial performance are not measures of creativity. These outcome variables may be linked to creative efforts, but it would be folly to use these as a proxy variable for creative performance.

Conclusion

This article introduced our framework of creativity strata, and discussed how TMT, organizational resources and strategies, and organizational climate and culture influenced corporate creativity. As creativity researchers continue to explore organizational phenomena, we recommend further work in conceptualizing the level at which we are interested. In addition, the macrostratum needs additional measurement formulation.

Research in corporate creativity is useful in the extent it is translational. From a practitioner standpoint, there are recommendations that can be gleaned from this article. First, a TMT that is functionally diverse and values innovation should lead to increased firm creativity. Second, a more ambidextrous company that has strategies concerning its human capital around innovation should lead to increased firm creativity. Finally, the outgrowth of the TMT and strategies should lead to a more supportive culture and climate that lead to increased creativity.

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Craft

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Introduction

In the first part of the chapter, we introduce and consider craft from the perspective of mainstream cognitive science which defines creativity as an attribute of an individual human mind. Specifically, we consider the information processing model which takes the computer to be a metaphor for the brain and which frames creativity in terms of the discovery of novel and innovative solutions. We then contrast this view with craft which, through its activity, respects and seeks to foster skilled working techniques using traditional materials. Viewed in this way, craft does not appear to provide a suitable platform for exploring innovative solutions, nor to draw upon the human mind’s capacity to be creative as defined by mainstream cognitive science.

In the second part of the chapter, we change perspective and concentrate on the process of crafting rather than on its outcome. In doing so, we propose an alternative definition that equates creativity with the development of circumstances that facilitate uncertain or unpredictable consequences. Far from a nostalgic backwater of human activity, this interpretation presents crafting as an activity that creates its own future and, in so doing, highlights as well as undermines certain fundamental assumptions that are made within traditional cognitive science about the nature of intention and of agency and about the location and function of the human mind.

The Meaning of “Craft”

“Craft” is an odd word. As a noun, it is somewhat ambiguous. It may be used to describe a domain of activities requiring skills acquired through training and experience. So far so good, but it may also refer to the outcome of these skilled activities in a way that implicitly but mysteriously distinguishes craftwork from art-works, from the outcomes of mass industry and from the products of scientific endeavour.

For example, keyhole surgery is not generally considered a craft whereas the work of a locksmith is. It is not altogether clear what distinguishes these two activities. “Craft,” as a verb, is altogether more straightforward. It describes a skilled gesture that arises from training, experience and tradition. As will become apparent, whether or not “craft” is seen as a creative activity depends a lot on whether we use “craft” as a verb that refers to a masterful performance or as a noun referring to a product or profession. In order to understand why this should be, it is necessary first of all to look at how we understand creativity.

A History of Psychology in 500 Words

Within the domain of psychology, creativity is commonly understood to be a process that takes place within the human mind and that leads to the production of a new and useful innovation or product. In light of the opening paragraph, it is immediately apparent that this mainstream psychological understanding defines creativity by the outcome of a process rather than by the nature of the process itself. In order to be able to map the relationship between creativity and craft, it is important to understand why this particular view of creativity gained traction within psychology.

For this purpose, we can situate the beginnings of the modern science of psychology with the establishment of two laboratories in the 1870’s. One was founded by William Wundt in Germany, the other by William James in the United States. The research that took place in these two labs was predicated on two quite different theories of the mind and the tension between these two positions

has influenced the nature of psychological research ever since—including research into creativity. Wundt believed that the way to understand the human *psyche* was to begin by determining how the process of thinking was organised. Effectively, Wundt's aim was to create an anatomy of the mind. This approach came to be known as structuralism and its immediate philosophical antecedents can be found in the writings of Descartes although, as we will see, they can also be traced back to Aristotle.

In contrast, James' functionalist approach to mental activity focused efforts not on the structure of thoughts, but on what thinking did in relation to the world. Functionalism was associated with the development of a contemporary philosophical movement known as pragmatism and has its roots in the writings of Darwin. The most dominant psychological model of the 20th century, B.F. Skinner's learning theory, took functionalism to an extreme by excluding the notion of mind altogether and concentrating exclusively instead on the study of an organism's reaction to environmental stimuli. In 1959, Noam Chomsky launched an influential attack of Skinner's model of verbal learning and, by extension, on behaviourism in general. Chomsky argued that a model of infant language acquisition based exclusively on learning, in the absence of an innate language structure (what Chomsky termed a "Universal Grammar") could account neither for the rapidity nor the flexibility of language learning. This heralded the so-called Cognitive Revolution in psychology and the creation of a new discipline, Cognitive Science. In the revolutionary fervour, cognitivism not only denounced behaviourism, but dismissed functionalism in general. As a result, for the last 50 years, cognitive science has situated itself firmly within a structuralist framework and an information processing model of the mind has developed, influenced by the powerful notion of the computer as a metaphor for the brain.

No Room for Craft in Conceptual Space

The computer metaphor suggests that the brain takes in information and organises it into a representation of the world. This internal representation can then be used as a decision-making tool in order to produce an appropriate response to the environmental situation on which the model is based. The role of Cognitive Science is to map out this decision-making process, to identify its various stages, and to describe the nature of the data manipulation that takes place. This view of cognition has two important consequences for how we see creativity.

First, it locates the act of creation in the brain and identifies the human (or at least the human brain) as an active and intentional creative agent. We have an idea and, if we think it is a good one, we take the necessary action to bring it about. The view of humans as active agents who create their own destiny by imposing their will upon the world certainly chimes with the pervading western anthropocentric, post-enlightenment manifesto. By giving an ideational origin to creation, the information processing model draws a clear and linear direction of causation from the brain to the environment. Given that the birth of Cognitive Science was a direct reaction to behaviourism, it is probably no coincidence that learning theory predicts the exact opposite causal relationship. For Skinner, it was environmental conditions that determined human behaviour.

Second, and quite consistent with structuralism, the information processing model envisages the mind as a virtual space. For example, in her influential book, *The Creative Mind: Myths and Mechanisms*, Margaret Boden (2004) suggests that creativity occurs within, what she calls, a conceptual space. An example of a conceptual space from the domain of craft might be the schema for a cup. A conceptual space sets constraints on what can and cannot be classed as a cup. The creation of an innovative cup can occur in one of two ways. First, it may take place by searching for undiscovered possibilities that might exist within the confines of the pre-existing conceptual space. Second, Boden describes a more radical form of creativity in which a creative solution is found not within the conceptual space, but by changing the shape of the space itself—perhaps by dropping a constraint or converting a constraint into its opposite. With regard to the cup, this would require conceiving of something that was not a cup and yet, once it was brought into existence, had the effect of stretching our understanding of what a cup could be by expanding the conceptual space for "cupness."

Taking this cognitivist understanding of the mind and applying it to the domain of craft gives the impression that, far from facilitating creativity, craft represents the antithesis of novelty and innovation. By respecting traditional, skilled work practices, the crafts-person understandably turns his/her gaze towards the achievements of the past rather than the possibilities of the future. In addition, craft professions or guilds are organised by material: stone-masonry, carpentry, ceramics, etc. The properties of these materials, which lie at the heart of a craft guild, do not change. Travertine is the same material now as it was when Roman masons used it to build the Colosseum. It seems clear that traditional work methods combined with the timelessness of ancient material is not an ideal partnership with which to explore and extend the limits of conceptual spaces. Turning to the history of craft and its relationship with other cultural activities, past and present, the impression of craft as the antithesis of creativity becomes even stronger.

The History of Craft and the Birth of Art

During Plato's time, the Greek words *techne* and *episteme* both referred to knowledge. According to Heidegger, Plato uses the two words interchangeably. However, in post-Platonic ancient Greece, *techne* was increasingly used to refer to the sort of knowledge necessary to perform a craft or trade, what we now call "tacit knowledge," leaving *episteme* to refer exclusively to abstract or intellectual knowledge. In addition, the distinction between the two began to establish a hierarchy in which *techne* was viewed as an inferior form of knowledge to *episteme*. The devaluation of manual know-how and the differentiation of doing from thinking,

remains deeply embedded in western culture to this day. Indeed, the education systems of most developed countries are predicated upon it.

Given this historical backdrop, craft's position in the creative doldrums would not be surprising were it not for the fact that its close cousin, art is viewed as the quintessentially creative domain. In his book, *The Craftsman*, Richard Sennett (2008) uses details from the autobiography of the renaissance goldsmith Benvenuto Cellini to explain how this situation came about. In ancient Greece, no distinction was made between art and craft and none was needed: the concept of art as we know it today did not exist. This situation continued into the middle ages by which time crafts, including painting and sculpture, were organised into strictly controlled guilds. When a young person, usually a boy, entered a seven-year apprenticeship, the workshop literally became his home; with the master craftsman *in loco parentis*. The apprentice learned the skills of the trade before going on to spend a further 7 years as a journeyman around Europe, during which time he learned how to put these skills into practice in different social and material contexts. Sennett emphasises the extent to which guilds, craft and apprenticeships were embedded within the community. This collective approach was encouraged by the guilds by, for example, advertising the place of origin of a product rather than the identity of the workshop or its master.

In this context, Cellini, a master goldsmith, began changing the traditional approach to working with gold with significant social and cultural repercussions. Cellini's workshop began to produce scenes or pictures with gold in a way that was similar to the approach of painting or a sculpture. In so doing, Cellini moved away from making objects as products and towards conceiving of objects as vehicles of expression. Significantly, what these objects came to express (or at least were seen to express) was the inner character of Cellini. This had important consequences. It meant that Cellini broke away from the communal anonymity of the guild system. He became rich and famous, not by, for example, the selling of a simple salt cellar, but by creating a unique salt cellar that expressed part of Cellini. Cellini became a brand. No one else was able to express Cellini like Cellini could. The value of the brand depended not only upon the skill but upon the character of Cellini. In this way, the concept of a creative personality developed out of the original role of master craftsman.

To summarise, the renaissance period begins with the birth of conceptual twins: art and artistic genius. The act of creation was transformed from a communal endeavour to an elite activity. Art was able to emerge and escaped the confines of craft and its social structure by redefining creativity as the expression of the internal emotional and cognitive turmoil of the artistic temperament. Interestingly, Sennett describes how, the contemporary renaissance philosopher, Pico della Mirandola understood the development of the artistic temperament to be an indication of a wider development of human self-determination and coined the term *Homo Faber* to mean "Man as his own maker."

Creative Thinking

Let us take stock of where we have got to. We began by suggesting that mainstream psychological models couch creativity in structural terms, locating the origin of creativity in the mind which, in turn, is housed in the brain. Second, we saw that from ancient times, thinking-with-the-mind has been considered to exist on a separate and higher level from thinking-with-the-hands. Indeed "thinking" and "mind" are now so inextricably linked with the brain that thinking-with-the-hands is almost an oxymoron. Third, we saw that art came into existence when the manual activity of a goldsmith made a paradigm shift between these two levels. This shift occurred when it became accepted that the creative output of the goldsmith was predicated on the unique, personality of the artisan. Taken together, these three points suggest that creativity is essentially viewed as an intellectual activity with the manual activity of craft therefore lying beyond the pale of western creative endeavour.

Creative Doing

Having established, from a structural perspective, that creativity has a limited part to play in the domain of craft, we would now like to return to our opening statement and explore what happens to the notion of creativity and of thinking in general when we consider "craft" as a verb rather than a noun—that is, as a word that describes the gesture of crafting rather than its outcome. We will show that a very different picture of what it is like to be a human involved in a creative activity emerges when we focus on the process of craft rather than on the structure of the mind (see Glăveanu (2017) for a summary of the psychological research on the relationship between creative action and craft). The study of ontology is concerned with investigating the nature of being and it will become apparent that craft, as a process, reveals an ontological framework that is more aligned to the functionalist psychology of James and the philosophical pragmatism of John Dewey than the structuralism of Wundt and Descartes.

At beginning of the 20th century, in his book *Creative Evolution*, Henri Bergson (Bergson and Mitchell, 2009) swam against the tide of more than 2000 years of western cultural development by proposing that the defining emergent evolutionary feature of the human intellect was not "wisdom" but "making": In particular, he drew attention to the human propensity to use tools to make further tools and suggested re-classifying *Homo Sapien* as *Homo Faber*. As we have seen, it is not the first time someone has used *Homo Faber* to refer to our species. But, when Pico used the term during the renaissance, he was articulating the view that man had a hand in the creation of his own internal character. If we now consider Pico's internalist assertion in the context of Bergson's emphasis on tool-making as the defining human cognitive activity, we can see that man-as-his-own-maker can also be externalised to refer to the way in which a craftsperson might observe the unfolding relationship of hand, tool and chosen material that takes

place before his/her eyes. Rather than seeing thinking as the exclusive domain of neural activity, it becomes possible to envisage cognition as a process whose focus is to be found, not in the brain, but in manual activity—in what Kirsh and Maglio (1994) refer to as “epistemic action.” For example, instead of seeing a drawing as the representation of a cognitive event (and the outcome of manipulating a conceptual space) Ingold, (2013) in his book *Making*, concentrates instead on the movement of the pencil across the paper. This change of register reveals drawing to be an act of discovery, making it possible to envisage design as happening, not in the head, but in the improvised tracing of a line.

Drawing as an activity of discovery emphasises the unpredictable nature of creativity. In *The Nature and Art of Workmanship*, David Pye (1995) noted the extent to which an industrial manufacturing process is designed to be entirely predictable. He refers to this as “the workmanship of certainty” and contrasts it with “the workmanship of risk” of craft practice in which:

the result of every operation during production is determined by the workman as he works and its outcome depends wholly or largely on his care, judgment and dexterity (Pye, 1995, p. 52).

Ingold and Pye formulate creativity neither in terms of the pursuit of novelty and radical change nor as the outcome of a divergent thinking style within one of Boden’s conceptual spaces. Rather, they introduce the idea that bodily actions that facilitate unpredictable situations are, *de facto*, creative. Given the inescapable fact that bodily action always takes place in the world, the reformulation of creativity as an agent of uncertainty also implies that creativity must arise out of a delicate balancing act between, on the one hand, the craftsperson’s actions and, on the other, the influences of the environment upon the craftsperson.

Ironically, the structuralist model of the mind portrays creativity as a retrospective action (the physical object is a representation of a pre-existing mental concept) whereas Pye’s use of the word “risk” implies that the experience of the craftsperson is one of creative anticipation. So, by focusing on action rather than outcome, craft is transformed from a domain that is nostalgically attached to past traditions into a force that is directly implicated in creating its own future. This fundamental change in perspective reconfigures the environmental architecture of creativity in two interesting ways.

First, “the workmanship of risk” paradoxically reduces the risk of accidents to almost zero. In a “workmanship of certainty,” an accident can be defined as a departure from the pathway whose direction and outcome has been defined in advance. In the “workmanship of risk,” the outcome is not predicted in advance. It is the process itself that brings about the future and so the concept of an accident as an undesired state loses all meaning.

Second, craft-as-action undermines the concept of creative constraint. The structural model of creativity is predicated on an ancient Aristotelian notion called Hylomorphism (from *Hyle* meaning matter and *morphe* meaning form) which posits that any object can be divided into the matter of which it is made and the form that matter takes. Hylomorphism prepares the ground for a hierarchal model of creation based upon the notion that human intention imposes form on inert matter. In contrast, the process of crafting suggests a collaborative exercise between human gesture and the properties of materials. The craftsperson experiences material as an essential partner in a distributed creative system rather than as a dead weight against which he/she must pit his/her will.

In this section, we have begun to consider the significant repercussions of re-naming ourselves *Homo Faber*. With man as a maker and creativity as a process, the locus of cognition moves out of the skull towards the point where the process is visible—between the hands. With the *dura mater* no longer marking its boundary, the spatial coordinates of the mind become fluid—determined instead by the activity in hand. This has implications for what we understand to be the driver of creative activity. With the mind in the head, agency also automatically locates itself there. However, once things in the world become part of the creative activity of the mind, it is difficult to see how we can continue to describe material as lacking agency. In the next section, we will present a theoretical model of the mind that is explicitly predicated on the notion of material agency in the context of a spatially extended mind. This, in turn, will enable us to describe an ontology which includes craft but extends beyond its frontiers and which establishes creativity as a recursive process in which man is shaped by the tools he makes and the material he uses.

Material Engagement Theory

Material Engagement Theory (MET) was first introduced by Lambros Malafouris and Colin Renfrew within an archaeological context in a collection of essays edited by DeMarrais et al. Renfrew (2004) and further developed by Malafouris both within archaeology (2013) and also through the anthropological study of contemporary pottery making (2008). MET is far from being the only systemic account of making. To name but two others, Ingold (2013) describes a similar ontological position in his book, *Making* and Anthony Chemero (2009) addresses the issue from within a Cognitive Science framework in *Radical Embodied Cognitive Science*. We have chosen MET because, by observing potters at work, Malafouris has been able to make explicit links between the behaviour of material, the meaning of material change, and the relationship between material transformation and human cognition in a way that is entirely consistent with the process of craft as we have been describing. Below, we summarise four important principles of MET before going on to present a short case study in order to show how these principles manifest themselves in action.

The Extended Mind: As we have seen from the example of drawing, cognition can be said to happen not in the head but on the page, at the point where graphite touches paper. Cognition is enacted through an active relationship between human and material.

Material Agency: Instead of viewing agency as a human attribute, the future course of events is predicated on (or emerges out of) the interaction between humans, tools and material. As such, the way a material behaves has an influence on the overall behaviour of the creative system.

Enactive Signification: If we see drawing as an explorative act rather than a representative one, then the sense that a drawing gives to us and its materialisation are recursively co-dependent. By this we mean that the meaning of a drawing can be neither separated from the physical act of drawing nor from the specific materiality of pencil and paper. Visual perception is not an information processing task, but a physical sense-making experience in which meaning-making takes place in a sphere that is unmediated by language.

Creative Thinging: In his paper *The Thing*, Heidegger (Heidegger and Hofstadter, 2013) coins the term “thinging” in order to refer to the agency of a non-living entity. By linking “creative” and “thinging,” Malafouris (2014) adapts the term to refer to the activity of an extended mind as it emerges from the relationship between human and material. Although similar, “Creative thinging” is distinct from the term “epistemic action” that we met earlier in that epistemic action refers to a human action whereas creative thinging describes the activity of a transitory creative system (which includes a human). We can understand creative thinging to be a systemic formulation of, thinking-as-doing.

We will now turn to the case-study which will enable us to bring to life the extent to which thinking is shaped by the physical qualities of material. Our aim is to highlight evidence for the concepts of extended mind, enactive signification and material agency and to show how they develop together into the process of creative thinging. The case study is a first-person description by one of the authors, Paul March as he goes about his work as a ceramic artist. The reported action occurred on the same day that Paul March drew up the plan for this chapter: a fact worth knowing because, as will become clear, writing and crafting become inseparably intertwined.

Case Study: How Material Sculpts Thought

I spent the morning making a plan for this chapter and in the afternoon, I went back to working with clay. My first task was to test out a new surface treatment for a sculpture-in-progress. Normally, I would test this by rolling a lump of clay into a rough tile-shape before applying the surface treatment to one side. But as I was about to start I looked across the workshop and my eye caught sight of a small goblet that I had made about a year before. The goblet had also been a test—this time of the material properties of a mixture of paper, flax and clay. Once the test was complete, I had hoped to be able to drink my morning coffee from the goblet but the paper-clay mixture turned out to be porous and so, despite its success as a test, the goblet itself was useless as a functional vessel. But when I glimpsed it again, I realised that its rounded surface offered a better approximation to the form of the present project than a flat tile and so I started work on a second cup.

I began by rolling small pieces of stoneware clay into thin sausage-shapes, with a view to using the coiling method. As the name suggests, the method involves building up the walls of a vessel by spiralling a cylindrical coil of clay onto itself in a circular motion before smoothing down the joint between layers. A more-or-less cylindrical vessel such as a goblet grows naturally from this procedure. When the smoothed clay sides had lost some of their humidity, I held the conical object in my hands with a gesture that was meant to feel and adjust the circularity of the vessel. The clay felt comforting and I imagined sitting at the breakfast table with the cup-to-be full of coffee in my hands. As I did so, I began putting pressure on the clay and the cylindrical form adapted itself into the shape of my palms. I pressed harder and then I relinquished the grip. I enjoyed the vibrancy of the gesture and the impression it made with the clay. With two fingers on the inside of the rim, I re-formed the vessel into a cylinder and then repeated the process. After a couple of rounds of this game it became pretty clear that I was no longer making a cup. I was sculpting a vessel by cupping my hands.

Once it was finished, my next task that afternoon was to test the same surface treatment for another project—this time one that had porcelain as its clay substrate. I am a sculptor and, as I will go on to describe, porcelain does not lend itself to sculpting and so I use it very rarely. I opened a bag of porcelain and touched the sticky clay. As I did so, I realised that the morning plan for this chapter was beginning to change and that what I was about to do would change it further. For the second time that afternoon, I rejected the intention of making a test-tile and began work on sculpting another cupped-vessel. I intended to compare and contrast the influence of porcelain and stoneware on the creative process in order to write about it here.

The plastic qualities of porcelain change very rapidly as water evaporates. Within the space of 15 mins, the clay goes from being super-elastic, like bread dough to brittle, like toast. Gestures that work so well with stoneware are not at all suited to porcelain. Even the tools I normally use feel ill-adapted. I have worked for years with stoneware and I am an expert in its behaviour. In contrast, my lack of experience with porcelain probably contributed to the clumsy work procedure that I could see unfolding before me. The struggle with porcelain brought into stark relief the plastic quality of stoneware that familiarity had rendered invisible to me. Working with stoneware gives me few surprises. My hands move easily between its possibilities and its limitations, whereas porcelain leaves me continually thwarted by the failure of each gestural intention. As I cupped the cylinder of porcelain in my hands, in place of the tight, elastic responsiveness of stoneware, I felt the slack emptiness of those areas that were still wet and the stubborn intransigence of those that had already lost too much water. Unlike the work with stoneware, the encounter with porcelain was a dispiriting experience. As a result, I spent less time on it, not least because, beyond a certain point, the clay simply stopped responding to my gestures, discouraging further gestural reaction and closing down the possibilities of an exploratory relationship.



Figure 1 On the right of the photo, the dark cup is made from stoneware with the porcelain version to its left.

Nine Lessons of Material Change

The image (Fig 1.) of the two unfired vessels, side by side (before the application of the surface treatment for which they were both tests) provides a vivid demonstration of the differential influence of material and of familiarity of material on the process of creation. In addition, this short case study highlights nine specific features of the process of creative crafting.

- 1) The familiar feeling of stoneware and of tools and the automatic recourse to the use of tiles as test samples all indicate the extent to which habitual work practice organises present activity. This undermines the idea of prior intention as a manifestation of a human agency that is determined by the activity of the executive function system (anatomically located within the pre-frontal lobes). It suggests instead that intention arises procedurally, through and within the extension and adaption of ongoing activity. By suggesting this, we do not seek to deny the crucial part played by the brain's pattern of neural activity. What we seek to question is the metaphor that equates the prefrontal lobes with an executive board. If a business metaphor is necessary, that of a cooperative seems more apt.
- 2) A change of clay disrupts habitual gestures, turning an expert tool user into a clumsy one. This illustrates the extent to which gestures, tools and clay, work in concert. To define one of these three elements in the absence of the other two is meaningless. Instead, expert gestures, familiar material and well-adapted tools should be seen to come together to form a temporary unit of cognition—an extended mind that functions through creative thinging.
- 3) A change of clay use, from stoneware to porcelain, reveals the extent to which the familiarity of stoneware has become almost literally incorporated into the bodily awareness of the sculptor. In this way, the division between what is human and what is clay is blurred as a lump of stoneware becomes a prosthetic organ of creative exploration.
- 4) The observation of features in the environment (in this case, noticing a goblet on a shelf) disrupts procedural intention. The emergent new direction is therefore not the result of an ideational change occurring in a virtual, conceptual space but is the next step in an encounter that happens in the real, physical space between a human and non-human entity. The pattern of relationship between the two delineates, once again, an ephemeral extended mind.
- 5) The formation of a cylindrical shape such as a cup emerges easily and naturally from the coiling method of construction—demonstrating that unfolding form, material plasticity and habitual work practice are co-dependent.
- 6) The making of a prototypical cup was disrupted by the agreeable feeling of squeezing the clay form between the palms. In this way, a change in habitual work practice was conceived, not in the head, but through a sensitive engagement with material.
- 7) The repetitive gesture of deforming and reforming the clay cylinder between the palms was described in the case-study as a game, suggesting that a change of intention can be seen as occurring through the uncertain consequences of engaging in play.
- 8) Making the cup and writing this chapter are linked by a transactional relationship. Each is responsible for giving form to the other.
- 9) The concept of a cup as cylindrical container is replaced by the concept of a vessel that is sculpted by the same gesture of the palms that will cradle it later when it is filled with hot coffee. This cognitive transformation does not take place in a virtual conceptual space. The concept emerged through enactive signification—the collaborative engagement with material that has been described through the previous eight points. In this respect, cognition and material activity are indistinguishable. A change in meaning is brought about, not by a linguistic reinterpretation, but by the gesture of holding the clay vessel between the palms and experiencing it both as a cup and as the sculpture of a cup.

Conclusion

The theories and examples offered in this chapter provide evidence of a profound relationship between craft and creativity. This relationship is based on the fact that both creativity and craft are ultimately grounded in the co-participation of person and world in the process of making. We use “making” here in a wide sense that does not exclude thinking; on the contrary, the concept of “creative thinging” brings the two together. In order to describe how creative thinging is exemplified by the context of crafting, we have introduced an ontological shift. Instead of conceiving of creative thinking as taking place exclusively inside the mind, both isolated from and yet somehow influenced by the “outside,” creative thinging happens at the interface between person and world, between self and other, between mind and matter. This paradigm change towards the notion of “making” as a process of engagement with material, society and the world of culture is long overdue in creativity research and it is by exploring unconventional topics like craft that this encyclopaedia encourages us to challenge a series of implicit assumptions about the nature of creativity.

The practice of craft and the process of creativity are thereby inseparably intertwined. In contrast, the historical separation of art from craft that we have highlighted reflects a schism between, what is known as “little” and “big” creativity. On the big side, the revolutionary creations of the artist or innovator, shape his/her field allowing him/her to leave a mark on society. By definition, big creativity is highly visible. On the little side, the process of creative expression that continuously develops, builds and maintains human culture and society either goes unnoticed or is viewed as mundane. Today we live in an age in which crafts are being rediscovered and are gaining a new appreciation. Perhaps we can take this as a sign that society is beginning to reconsider creativity as something more democratic, participative, and therefore more accessible to all.

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Creative Class and the Creative Economy

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Introduction

Creativity, according to *Webster's*, is “the ability to create new meaningful forms.” [Dean Simonton \(2000\)](#) described it as the ability to create something useful, that works and is non-obvious or, as he succinctly puts it, is the “conjunction of novelty, utility and surprise”. In his landmark book *The Lever of Riches* (1992), a sweeping study of technological creativity from classical antiquity through the Industrial Revolution the economic historian Joel Mokyr put creativity in a Promethean frame:

Economists and historians alike realize that there is a deep difference between *homo economicus* and *homo creativus*. One makes the most of what nature permits him to have. The other rebels against nature's dictates. Technological creativity, like all creativity, is an act of rebellion. (p. viii)

Yet creativity is not the exclusive province of a few select geniuses who can get away with breaking the mold because they possess superhuman talents. It is a capacity that everyone possess, to varying degrees.

Creativity has become a key driver of the Creative Economy. The old Industrial Economy which was powered by raw materials and physical labor has been supplanted by a new Creative Economy powered by knowledge, innovation, and human creativity. This Creative Economy is composed of Creative Industries which span sectors from science and high-tech, research and knowledge industries, to media, music, design, and the arts. This new Creative Economy is the principal driver of innovation, jobs, and economic growth in the advanced nations today.

Capitalism has expanded its reach to capture the talents of eccentrics and nonconformists who would once have been viewed as bizarre mavericks operating at the bohemian fringe, placing them at the very heart of the process of innovation and economic growth. These changes in the economy and in the workplace have in turn helped propagate and legitimize similar changes in society at large. The creative individual is no longer viewed as an iconoclast; he or she is the new mainstream. Indeed, the growing ranks of creatives are part of a new and rapidly expanding class of workers the Creative Class, who work in science and technology, knowledge work and the professions, arts, design and media, and who make up anywhere from a third to a half of the workforce in the advanced nations.

Creativity has come to be the most highly prized commodity in the economy—and yet it is not a commodity. Creativity is an attribute of people and as such it annihilates the social categories of gender, race, ethnicity, and sexual preference. Today's Creative Economy requires diversity, because every single human being is creative and can potentially contribute to it. And while people can be hired and fired, their creative capacity cannot be bought and sold, or turned on and off at will. So, the workplaces have changed and continues to evolve. Schedules, rules and dress codes have become more flexible to cater to how the creative process works.

This entry discusses the rise of the creative class, the creative economy, and creative cities, and the opportunities and challenges they pose for modern society.

Creative Industries and the Creative Economy

Creativity has become the key factor in the economy. In virtually every industry, from automobiles to fashion, food products to information technology, the long run winners are those who can create and keep creating. This has always been true, from the days of the Agricultural Revolution to the Industrial Revolution. But in the past few decades, the business community has come to recognize it clearly and act upon it systematically.

It's become commonplace to say that this is an “information” or a “knowledge” economy ([Machlup, 1962](#); [Bell, 1973](#); [Drucker, 1995](#)). But, what's more fundamentally true is that the economy is powered by creativity. Both at work and in other spheres of life,

creativity is, creativity is more highly valued and cultivated more intensely than ever. The creative impulse—the attribute that distinguishes humans, from all other species—is now being unleashed on an unprecedented scale.

John Howkins (2002) was among the first to use the term “creative economy.” In his 2001 book *The Creative Economy*, he identified fifteen key creative industries, including software, R&D and design, and creative-content industries like film and music. These industries produce intellectual property in the form of patents, copyrights, trademarks, and proprietary designs.

But it would be a mistake to suppose, that creativity can be reduced simply to the creation of new blockbuster inventions, products, and firms. In today’s economy, creativity is pervasive and ongoing: it drives the incremental improvements in products and processes that keep them viable just as much as it does their invention. Moreover, technological and economic creativity are nurtured by and interact with artistic and cultural creativity.

The growing salience of the Creative Economy is powered by the rise of Creative Industries. The share of overall employment in these industries which span high-technology, knowledge work, and arts, culture design, and media has grown significantly in the past couple of decades, and entirely new creative sectors such as computer graphics to digital music and animation have emerged. Meanwhile, economic activity in traditional manufacturing industries has shrunk as a share of overall activity as traditional production has either gone offshore or become more reliant on automation. Over the past several decades, the economies of the advanced nations have shifted from industrial to Creative Economies.

The shift to the Creative Economy and Creative Industries entails three big economic shifts (Caves, 2000; Scott, 2014; Menger, 2014). First, the products and services of the Creative Economy are more tailored to the subjective tastes of the consumer: which books, music, movies or games will succeed in market are hard to know in advance. It is very hard to know or predict what will be a “hit” in advance. For this reason, the Creative Industries face great uncertainty. Second, the Creative Industries tend to rely on the Internet and digital forms of dissemination. That means once these creative products are produced it costs very little to distribute them. Third, the Creative Economy takes the form of a winner-take-all economy, where film and music superstars garner a disproportionate share of rewards.

Creative workers, as Peter Drucker (2012) long ago pointed out, cannot be motivated merely by money, but seek intrinsic rewards that come from working on interesting and challenging projects with interesting colleagues and collaborators in comfortable flexible surroundings on their own with flexible schedules. As Drucker pointed out, rather than being treated as conventional employees, knowledge or creative workers must be treated more like volunteers whose commitment to the organization or company is contingent, and derived not from their pay or monetary rewards but from the challenge of their mission and the nature of the work itself.

This has given rise to sweeping changes in the workplace. These include new organization forms and workplace designs which seek to nurture and harness creativity. It is visible in new more loft-like office designs which emulate artists’ studios, more flexible schedules which morph work and leisure, and more casual dress codes. Creativity cannot be “forced” out of workers and does not march to the strictures of scientific management or the industrial assembly-line. And new structures have emerged to cultivate it. These include the ascendance of onsite employee amenities like catered meals and recreational facilities, and also the rise of new co-working spaces as other organizational forms of the so-called sharing economy, which allow for freelance workers to realize benefits of specialization that were previously only available within a firm.

The Creative Class

The economic need for creativity has registered itself in the rise of a new class, which we call the creative class (Florida, 2014). Its members’ economic function is to create new ideas, new technologies, and/or new creative content, and they work in fields such as science and engineering, architecture and design, education, arts, music and entertainment. Around this core, the creative class also includes a broader group of *creative professionals* in business and finance, law, health care and related fields. These people engage in complex problem solving that requires a great deal of independent judgment and high levels of education. But membership in the creative class is not simply a function of educational attainment. Some of the creative class’s most archetypal members, like Steve Jobs and Bill Gates, Andy Warhol and Jimi Hendrix, did not have college degrees. Across the entire United States, nearly three-quarters of adults with college degrees are members of the creative class, but less than 60% of the creative class holds college degrees. But whether they are artists or engineers, musicians or entrepreneurs, PhDs or dropouts, what all members of the creative class share is a common ethos that values creativity, individuality, difference, and merit.

The key difference between the creative class and other classes lies in what they are paid to do. Those in the blue-collar working class and the service class are paid to do routine work, while those in the Creative Class are paid to use their minds – their cognitive and social skills.

The creative class has expanded dramatically in recent years. In 1800, it accounted for roughly ten percent of the US workforce, and it hovered between that and 15% until 1960. It increased gradually to almost a fifth of the workforce in 1970, to about a quarter of it in 1980, and with more than 40 million members, comprises about a third of it by the 2010s. Countries like Singapore, the Netherlands, and Switzerland have even higher creative class shares, between 45 and 50% of their workforces. And the shares are even higher in leading creative cities, like San Francisco, London, and Berlin.

Creative Cities

The history of human creativity and of human progress is in large part the story of creative cities. The Epic of Gilgamesh—perhaps the oldest known work of literature—closes with an awed description of the walls of the city of Uruk. Plato's *Republic*—which envisioned an ideal city—was a product of the cultural and intellectual flowering of the earthly city of Athens, as well as a broadside against its politics. Dante, Petrarch, Boccaccio, Brunelleschi, da Vinci, and Michelangelo all were born in or near the city of Florence. Great thinkers, artists, and entrepreneurs rarely come out of nowhere. They cluster and thrive in places which attract other creative people, and that provide environments that foster and support creative efforts.

Cities have long functioned as critical containers and mobilizers of creativity, attracting creative people from the surrounding countryside, while providing the structures, scenes and ecosystems which undergird and support creative effort. As the great Swedish economic geographer Ake Andersson (2001) a leading student of creativity and cities, put it: "Creative people need creative cities." Andersson noted the flourishing of creativity in four different cities from four very different eras: Athens circa 400 BC, Renaissance Florence, Enlightenment London and *Fin de Siècle* Vienna. One could add New York City and Silicon Valley and numerous others in the present era: He stated that, "The creative city as an informal and spontaneously evolving spatial organization has been the arena for all large-scale creative revolutions," (Andersson, P. 39) Andersson added: "In the course of the past 2500 years, a small number of relatively large cities have functioned as hotbeds of revolutionary creativity. These cities attracted a disproportionate share of migrants with creative inclinations, and they also facilitated the growth of creativity among those already present. Such cities were both used as arenas for presenting findings from elsewhere and as fertile locations for developing new ideas in collaboration with other creative people."

Even deeper in our past, the congregation of populations into progressively larger, denser, and less isolated groups may have been the prerequisite for humanity's further evolution. Archaeologists and anthropologists noted evidence of a flowering of artistic and material creativity that occurred roughly 40,000 years ago in Europe, reflected in everything from cave paintings, figurines, and jewelry, to the complex tools that allowed farmers to begin actively transforming nature. Some scientists attribute this leap to advances in cognition and memory. But pioneering studies by archaeologists and anthropologists put communities—not genes—at the center of this evolutionary watershed (see, Boyd et al 2009; Shennan, 2009). Their research described how the earliest leaps in human development occurred in early city-like formations, places where populations were growing denser, larger, and more clustered. Those leaps were products of people working and thinking together. Many of these cultural and artistic blooms withered when populations shrank, and communities unraveled. This research found close relationships between advances in toolmaking and population size. As people gathered into larger groups and came into contact with one another more frequently, knowledge was shared, retained, and advanced more easily.

Cities do more than just attract creative people and provide a broad environment or ecosystem for creativity; they stimulate it as well. They do this in two key ways, according to Simonton. For one, cities play a critical role in creative development. Creators need to be exposed to role models and mentors during their adolescence and young adulthoods. This is something that is much more likely to occur in cities, where more role models and mentors are likely to be available and where people are pushed closer together. And, talented and creative people, especially those who are high in openness-to-experience – the personality trait most associated with creativity – are much more likely than others to cluster in dense, diverse cities (Rentfrow, 2011).

Creativity is a product of diversity and diverse communities; it requires the cultural heterogeneity that is the hallmark of big cities (Page, 2010). Research found a close connection between the concentration of artistic bohemians and of gays and lesbians in a community and its levels of creativity and innovation (Florida, 2014). It is not that the bohemian or gay community is more technologically innovative than others. Rather, higher concentrations of bohemians and gays reflects a greater underlying openness to the diversity and cultural mixing that attracts innovators and entrepreneurs, and thus propels innovative activity. As Simonton put it: "It goes without saying that an urban environment will afford a more diverse variety of potential priming stimuli than will a rural environment. The former, relative to the latter, is more likely to offer a world replete with different languages, cultures, religions and lifestyles," adding that: "The more urban the setting, the more diverse and hence more creative such a group is likely to be."

Creative Contradictions

But the rise of the creative economy and of the creative class also poses challenges for society and economy. Creative class workers today bear much more risk than the corporate and working classes of the old Industrial Age – as became all-too-obvious at the height of the economic crisis in 2008 and 2009. Stress levels too are high. The technologies that were supposed to liberate workers has invaded their lives.

The rise of the creative economy and of the creative class also led to deep social, economic, and political divides. Society is sorted and segmented by levels of education, the kinds of work people do, and where they live, and this in turn shapes ever more divisive culture wars and politics.

One of the most significant fault lines of the current age is the growing geographic segregation of the classes. Places where the creative class is more concentrated are economic winners: they have stronger economies, higher levels of income, and higher levels of economic growth. They are also more likely to vote for liberal politicians, which heightens partisan divisions.

Different kinds of people have always sorted themselves into different kinds of neighborhoods. Little Italy's, Germantown's, Harlem's, and other ethnic and racial enclaves have always been a feature of cities, as have artistic and cultural centers like New York's Greenwich Village. For better and for worse, college towns like Madison and Boulder have distinctive personalities and qualities of life, as do former manufacturing towns like Pittsburgh and Detroit. But the divisions between and within cities and regions – crossing urban, suburban and rural lines – have deepened with the rise of the creative economy. The economic and social geography have morphed into a veritable patchwork, with small spans of concentrated advantage juxtaposed against much larger swaths of concentrated disadvantage.

There are increasingly global divides too. People everywhere increasingly eat the same foods, wear the same kinds of clothing, and consume the same kinds of music and entertainment, no matter where in the world they live. This has in some ways made the world smaller and brought its economies and peoples closer together. But instead of reducing and flattening economic and class distinctions, it has made them sharper. The creative class in urban centers like London, Paris, Berlin, Stockholm, New York, Los Angeles, Toronto, Sydney, Tokyo, Shanghai, Singapore, Bangalore, Tel Aviv, Mexico City and Sao Paulo have far more in common with each other than with the working classes of their own countries. The defining feature of the creative economy is that it is winner-take-all and thus spiky – and it is getting spikier and more divided all the time. These worsening class divisions are at the heart of the populist backlash—the angry, backward-looking nationalistic politics that are on the rise around the world.

The rise of the creative economy also exacerbated global economic instability. Though the immediate occasion for the crash of 2008 was the bursting of the real estate bubble, in larger terms, it was the transitional crisis of the old economic order—the death spasm of an outmoded, exhausted system, and the birth pangs of a new one. The rise of the creative economy should be seen as a fundamental, epochal transformation, like the shift from agrarian feudalism to industrial capitalism, which was also accompanied by earth-shattering religious, political, intellectual, and social upheavals. The current moment has much in common with the Long Depression of 1873, which coincided with the rise of modern industry, and the Great Depression of 1930s, which followed the rise of mass production capitalism. This is the dawn of a new social and economic order.

Despite its instability, there are reasons for considerable optimism. In the new creative age, the most valuable economic attribute is not land or capital but creativity—an endowment that every human being shares in. For the first time in history, the logic of economic growth requires the fuller development and flourishing of human potential. This disruption is frightening, and the dangers of backsliding and civilizational atavism are real. But society is hopefully standing on the threshold of a much richer and more humane epoch.

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Creative Destruction

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Origin of Creative Destruction

Creative destruction is a macroeconomic term describing the process “that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one.” (Schumpeter, 1942, p. 83). Schumpeter popularized the term to describe a force metaphorically labeled ‘industrial mutation’. Similar to its biological counterpart, he described a process of permanent alteration and implied that it is similarly unplanned, unintended, and unpredictable. Schumpeter uses creative destruction to describe the force that allows new actors to rapidly enter an existing market and establish themselves in addition or instead of existing companies. Schumpeter observed that the introduced changes must be radical enough to impact the existing market, since the existing structures have a considerable market force. As established players, the market force is used to keep the status quo, or incrementally improve their position. If the new participants succeed with their radical change, established agents suffer a devaluation and will ultimately be destroyed. This destruction is a necessity for the next iteration of the business cycle.

Radical creative destruction was described as stepwise and cyclic, with revolutionary phases of renewal and destruction intertwined with phases of tranquility. According to Schumpeter, all these phases are part of the same process: either revolutionary replacements of existing structures or the implementation and absorption of change. Cyclic repetitions of these phases lead to long-term economic growth of the whole market. Since the renewing forces come from within, this process does not change the underlying system. Nevertheless, Schumpeter claimed that at some point these cycles create the conditions for the self-destruction of the system. However, for the capitalistic system he described, this has not yet happened in the predicted form and time.

The Historic Context of Creative Destruction

Schumpeter was not the first to develop the idea or the term of creative destruction. For example, Karl Marx had previously described a similar process without using the term. Marx had argued that an eventual self-destruction of the system through these destructive forces would be inevitable.

Werner Sombart also described a similar process in his early works. In the conclusion of his book on “War and Capitalism” (“Krieg Und Kapitalismus”), Sombart drew a connection between the deforestation of Europe, the rise of capitalism, and war as a force of creative destruction. In short, he stated that war created a demand for ships, which led to a shortage of wood. This deficit in turn created the need for alternative burning material and the development of metallurgical coal. As this was the inaugural moment for the steel industry, he suggested that the destruction (e.g. of forests) caused by war led to the creation of capitalism. Poetically, he summarized this: “In turn, a new creative spirit rises from the destruction” (orig.: “Wiederum aber steigt aus der Zerstörung neuer schöpferischer Geist empor”, Sombart, 1913, p. 207). This is particularly interesting as Sombart published this book on war as the enabler of capitalism just before the First World War was about to begin.

Marx and Sombart described the creative force of destruction as positive and, to some extent, inevitable. It seems that Schumpeter agreed with Marx and Sombart. However, taking their interpretation a step further, he suggested that the destruction of existing

structures is necessary and a positive contribution to the long-term growth of the whole system. It is Schumpeter who then explicitly popularized the technical term 'creative destruction' for a wider audience.

Theoretical Observations About Creative Destruction

Destruction and Creative Destruction

Destruction can be summarized as "damage beyond recovery or repair, changing something into a state of non-existence" (See Destruction and Creativity). This definition implies that the destructive force has no intention of creating something out of what it has destroyed. Moreover, destruction does not require a preceding constructive or creative process and does not refer to one artefact being replaced by a successor. Furthermore, while creative destruction is a cyclical process, a destruction is a one-off event.

Creativity and Creative Destruction

The extent of this Encyclopedia bears witness to the fact that creativity is a multifaceted and complex phenomenon. Nevertheless, there is some agreement to summarize it as the product of novelty and usefulness, possibly with an element of surprise in it. Creative destruction, generalized from the term introduced by Schumpeter (1942), similarly refers to a revolution through renewal, to a novel element replacing an existing one. To achieve this, the novelty has to be useful with considerable more value than existing solutions. These useful revolutions in creative destruction resemble qualities similar to the 'standard definition of creativity' (See Definitions of Creativity, Novelty). Furthermore, Schumpeter suggested that creative destruction is unpredictable in its timing and needs a quick implementation. It shares its suddenness with the notion of surprise that scholars like Margaret Boden attribute to creativity itself. Therefore, both concepts exhibit a great conceptual overlap with each other (See Novelty).

On the other hand, creative destruction refers specifically to a process or action. Other aspects of creativity have defined roles, at least within the economic system. Referring to the terminology suggested in Glăveanu's (2013) five-A framework for creativity, entrepreneurs would be the creative actors. Consequently, their product is the creative artefact, economic demand is the creative affordance, and consumers represent the creative audience. Similar to how the different aspects of creativity are intertwined, creative destruction relates to these elements but is, nevertheless, a distinctive sub-factor of creativity.

Consequently, creative destruction exhibits greater similarity to the creative action or process than to the overarching term of creativity itself. Drawing on the self-observations from early eminent scientists such as Hermann von Helmholtz and Henri Poincaré, Graham Wallas described the creative process as sequential, with five distinct stages. This model inspired a multitude of similar models, yet they do not cover how one creative process influences the next action. In contrast, a description of an iterative and full cycle of creation is the central concept of creative destruction. In addition to the sequential models of creativity, iteration plays a role in 'design thinking'. For this set of models, and based on the observation of creative practitioners, the economist Herbert A. Simon proposed that prospective problem solvers iterate through several phases such as 'define, research, ideate, prototype, choose, implement, learn' until they find a satisfying solution. This creative model shares its cyclic and iterative conceptualization with creative destruction, but it lacks a clear leap or shift at any transition from one phase to another, which defines creative destruction.

In summary and on a fundamental level, creative destruction is a process but therefore only one of the aspects covered by the term creativity. However, there is great conceptual overlap between novelty, usefulness, and even surprise as possible factors both for creative destruction and creativity. Moreover, neither the sequential model of creativity nor design thinking refer to destruction, either directly or indirectly (See Design Thinking and Surprise).

Innovation and Creative Destruction

The examples in previous sections demonstrate that creative destruction is often initiated by innovation. In fact, the revolutionary part of creative destruction is often depicted as a reordering of the productive process and goes back to the definition of creative destruction used by Schumpeter (1942). Innovation, outside the economical definition, is any technologically-backed novelty (Schneider, 2017), which does not necessarily end up causing a destruction. Under this point of view, history is full of examples of products that were innovative but did not replace existing ones.

Fundraising platforms such as Indiegogo and Kickstarter contain many brilliant innovations. The role of these platforms within the capitalistic economic system is to increase the reach of small innovators to accelerate their speed of reaching potential consumers. These fundraising platforms are promoters not only of the innovations, but also of creative destruction as a viable and important part of the system. Some of the most successful innovations on these platforms include a smart watch produced by a small startup company. With the help of the platform, it created enough impact to overcome the market dominance of existing watch companies. By now, smart watches are established products from computer and electronic gadget companies rather than traditional watchmakers.

At the same time, these platforms show a variety of innovations that did not even make it past the funding stage. These failures can also serve as examples for future innovators and cycles of creative destruction. Even large companies learned the hard way that innovation is not the only driver of creative destruction if the public is not ready. For example, global players built devices such as smart glasses with built-in cameras and head-mounted displays to augment people's surroundings. While these products failed,

their development led to an increased awareness of privacy issues. Thus, while every creative destruction process starts with an Innovation, not all Innovations become creative destructions. Moreover, the outcome of a development triggered by innovation within the circle of creative destruction is not predictable.

Occurrences of Creative Destruction

Economics

"Creative destruction" was introduced as a macroeconomic term with particular relevance for sociology, national, and international economics. This is evident from the use in Sombart's work and even from how it was popularized by Schumpeter (1942; p. 83): "This process of creative destruction is the essential fact about capitalism."

The fundamental idea is that markets are systems which undergo a continuous process of change, with phases of revolution followed by the assembly of these revolutions. Not dissimilarly from the biological evolution of species, and borrowing some of its terminology, markets continuously 'adapt' and 'mutate' based on 'environmental pressure' as new technologies, goods, and services become available. Just like for the individual creature, this inevitably means that older industries are swept away by ones with better 'fitness' for the changing market. For example, the car industry made manufacturers of horse-drawn carriages obsolete, and the computer industry replaced the manufacturers of typewriters. The creation and destruction of industries are paralleled in the job market and the development of professions and traits. While creative destruction hinders job security in the long run, the labor force migrates between different markets. Consequently, new industries create new jobs and professions along with the need for the adaptation of the national educational system. This example provides a glimpse into how creative destruction operates on a national or even international level and is part of the macroeconomic system.

Likewise, processes similar to creative destruction can be observed in microeconomic decisions. One interesting example comes from the development of the music recording industry during the past decades. Through the innovation of the phonograph, which led to the development of phonographic cylinders and the phonograph record known as vinyl, a demand for recorded music developed on a macroeconomic level in the early 20th century. While the music industry initially sold 78 rpm shellac and vinyl, the invention of the reel and later the cassette tape imparted a blow to the vinyl-related factories. The cassette was later replaced by the compact disc (CD), and the CD by streaming media. Often these technological changes were introduced by companies new to the market. For example, the compact cassette was introduced by Philips, which until then had been a manufacturer of radios, TVs, and shavers. The transition to streaming media is interesting, as the technology of peer-2-peer networks such as Napster was developed without a commercial interest, but still replaced existing music distribution systems through a 'revolution'. In the following adaptation phase, the commercialized streaming media almost entirely replaced the digital CD. As a result, many new recordings are now either released online or as analogue media. Interestingly, these are now often vinyl recordings or even cassette tapes, thus resembling earlier iterations in the cycle of creative destruction.

The process of creative destruction means that industries can never afford to remain stagnant, since competition will otherwise destroy them as progress advances. As Schumpeter (p. 82) wrote, "The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates." Under this view, stability, such as that advocated by equilibrium theorists, is not the optimal goal. Rather, constant turmoil and incessant changes in the status quo are to be sought in order to ensure progress and evolution. In this world, entrepreneurs are the catalysts of the change, and in a literal sense the real creative market participants.

Creative Destruction and Society

Human history has seen many destructions and reconstructions of societies, civilizations, and communities. Natural disasters and man-made destructions such as wars may completely change the features of a certain part of the world, yet people's resilience, combined with technological innovation, often result in new settlements being born from the ashes of previous ones. As Sombart argued, this particular aspect of creative destruction is at the core of the capitalistic society (See War).

The destruction of cities can be discussed through the lens of creative destruction as well. Take London and its well documented fires, for example. Early fires happened during Boudica's Revolt in CE 60, others are known as the Hadrianic fire in CE 122. Each time, the city was rebuilt and changed its structure and architecture. With the fire in 675, these changes started to have a less immediate and long lasting influence: some of the major buildings previously made from wood were replaced with stone buildings. This became part of the official regulations after the 'Great Fire of London', when the 1667 Rebuilding Act only allowed new structures to be made from brick and stones. Looking at the fires and the destruction of the city itself, the order of the destruction (fire) and creation (rebuild) seems reversed as compared to the definition of creative destruction. Nevertheless, considering the typical London architecture consisting of residential squares, this was a phenomenon that had started just before the fire and only became the dominant architectural style after large areas were to be rebuilt in a short amount of time after the fire. Here the destruction was not a consequence of a new invention, nor was it triggered by it. Instead, a novel design had already been ideated, and the innovation was waiting to be implemented as an alternative to rebuilding previously existing structures. Even though the rebuild happened before capitalism, which Schumpeter names as a precondition for creative destruction, the development of residential squares within the mercantilist society resembles aspects like the concentration of capital to generate more profit.

Similarly, while creative destruction in economics terms is specifically created by the competitive nature of entrepreneurs, natural disasters happen without the intention to compete with existing solutions. Nevertheless, and like the Great Fire of London, they can exhibit comparable phenomena. Talking about less destructive relationships between a community and its environment, in disciplines such as Environmental Sciences, Tourism, and Architecture, creative destruction entails a specific meaning closely related to the original definition from macroeconomics.

Creative destruction describes the process through which underdeveloped areas undergo a process of restructuring, in order to make their heritage appealing, and increase tourism. According to Mitchell (1998), there are five stages in this creative destruction process: “early commodification”, “advanced commodification”, “early-destruction”, “advanced destruction”, and “post-destruction”.

In the first stage, actors such as local businesses and governments create a market for tourists, for example by promoting a local historical site in an ‘idyllic landscape’. This stage is generally well received by the local population, as new tourists bring money to the community. In the second stage, what had been initiated in the first stage is amplified, with more and more local businesses joining in opening restaurants, hotels, and souvenir shops, and with the local government giving more weight to the tourism and hospitality industries. While all the actors involved in this process benefit from this stage, those who are not involved, for example residents who are not working in the industry, start feeling that the atmosphere of the community is changing, and it is no longer an ‘idyllic landscape’. In the third stage, more and more businesses are created to meet the demand from visitors, and this includes business that do not represent the historical or cultural value of the place, such as fast food restaurants and shopping malls. A growing number of residents develop negative attitudes towards this change. In the fourth stage, residents either resign themselves to the disruption brought in by the businesses, and try to partake in their benefits, or relocate. At this point, if left free to operate, disruptions will be major, such as the construction of big shopping and amusement centers completely changing the atmosphere of what once was an ‘idyllic landscape’. Finally, during the post-destruction stage, the place might find a new equilibrium, either by completely changing its outlook, or by partially going back to a less touristy destination.

While in economics, creative destruction often has an immediate impact on lives through the change of job specifications and locations of manufacturing – people are forced to change their profession or follow the work by moving to different locations – in the tourism industry the five-stage process described above implies less direct changes, as people’s wellbeing is impacted in other ways.

Creative destruction describes the process of the continuously changing economics and society. As a result of these changes, some industries and individuals will be better off, while others will lose – job, societal relevance, or useful knowledge. In its extension, this makes the moral dilemma of creative destruction visible: Should individuals develop and introduce innovations, knowing that new industries and professions will be created at the cost of making existing industries and jobs obsolete? Should society welcome electric cars as individual transportation as they shift production from one market segment and one location to another? Should people keep allowing artificial intelligence into manufacturing, online retail websites, academia, and other industries, knowing that they will solve problems faster and more efficiently, but will replace human workers? Is it even possible to change the course of creative destruction once it has begun?

Natural Sciences and Theory of Science

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it. Max Planck (translated in “Scientific Autobiography and Other Papers”, trans. F. Gaynor (New York, 1949), pp. 33–34); paraphrased as “Science advances one funeral at a time”

Science has been dotted by what have been called “Scientific revolutions”, that have either changed the way humans understand the world, or at the very least made life a little bit easier. Discoveries, include the description of the Solar System by Copernicus, the introduction of the number 0, or the discovery of wave-particle dualism; technology-based revolutions, improved daily life with transportation on wheels, mobile phones, and ball pens. The creative destructivity of these revolutions – the paradigm shifts, mentioned earlier – describes how previously accepted paradigms are superseded by their successors. For example, Copernicus placing the sun in the centre of the solar system replaced the geocentric model.

The geocentric model of the solar system assumed that the Earth was at the centre of the universe. Developed over many centuries by astronomers like Ptolemy, a sophisticated system with pre-calculated tables and catalogues of star formations predicted the position of the sun and moon. This scientific model was continuously improved and was precise in predicting the seasons for farmers and in aiding the navigation of travellers. Then, the heliocentric model was rediscovered and introduced to Europe by Copernicus in the 16th century. Similar to previous heliocentric models by scholar in ancient Greece, and following observations by Brahe, Kepler then formulated three laws that described the ellipsoid movements of planets. Galilei’s observations and Newton’s description of the laws of gravity finalized the creative destruction of the geocentric model, which was completely replaced by the heliocentric model.

Thomas Kuhn, who studied theory of science and who proposed the idea of ‘paradigm shifts’ in his 1962 book, had previously published ‘The Copernican Revolution’ in 1957. Kuhn, a Physics graduate who was mentored by a later Nobel laureate, was intrigued by the changes that led to the development of different fields within modern physics. Replacing the classical Newtonian mechanics, models proposed by Skłodowska-Curie, Einstein, Planck, and their contemporaries, revolutionized the understanding of nature. Their observations across the different disciplines in the natural sciences often replaced previously established models within a short time. Kuhn used these examples in his book to illustrate how new theories in continuously replace previously

accepted ones. Since its publication, new discoveries, such as the confirmation of the existence of the Higgs boson, have shown how a model similar to that of creative destruction can be applied to the natural sciences.

According to Thomas Kuhn, every field of scientific research undergoes the same cycle, now known as the Kuhn cycle: the tranquillity of day-to-day scientific problem solving activity, dubbed 'normal science', is troubled by more and more occurrences of the current paradigm not being able to solve problems. At this point, in a so-called "paradigm shift", a new paradigm is created, replacing the existing one. Within this newly created paradigm, 'normal science' can flourish again, 'solving puzzles' set out by the paradigm and using the methodology of the paradigm. Interestingly, the introduction of Kuhn's cycle was a paradigm shift in itself, especially in the fields of history and philosophy of science. Previously, the proponents of the old rationalist paradigm, with theorists such as Karl Popper, understood scientific progress as a continuous accumulation of falsifiable theories and ideas. Following the idea introduced by Kuhn, there are no more steady steps, but leaps between scientific paradigms. In its ultimate consequence, the Kuhn cycle predicts a replacement of itself, once too many conflicting observations have been accumulated. Interestingly, Kuhn shares this notion of self-destruction with Schumpeter's description of creative destruction.

It is worth noting that Kuhn's ideas of paradigms and revolutionary changes in science have been met with skepticism. A justification or even a summary of these arguments would exceed the current entry and is given elsewhere (e.g. Bird, 2001). Nevertheless, the idea of paradigm shifts in science has been around for almost 60 years and has since been used to describe progress in academia; it has also entered the English language as an idiom. Consequently, it is difficult to follow or even estimate the direct influence that Kuhn's writing has had on the scientific community without considering his influence on the popular culture.

Policy-Making

One of the drives of creative destruction is competition: entities need to keep reinventing themselves, or they face destruction. The same process can be observed in political institutions, where, for example, policies and regulations are written and dismissed to follow the pace of modern thinking.

The need for new policies is driven by phenomena such as innovation and change in socio-cultural sensitivity. For example, a growing environmental awareness in the past decades has led to an increasing number of policies for sustainability transition being created, both within and between nations (see e.g. Kivimaa and Kern, 2016). These range from local councils traffic bans to national plastic bag levies, to worldwide agreements to reduce carbon emissions. The apparent losers, in an economic sense, are entities such as plastic and car manufacturers, that need to reinvent themselves in order to continue to survive. What is more, there are scholars, such as Kivimaa and Kern, who argue that all policies that work towards a transition of some kind need to incorporate both elements of creation and destruction in order to be effective.

Arts and Media

The history of Art has also seen waves of new, revolutionary movements, such as Mannerism, Impressionism, and Cubism. Many of these movements corresponded to points in time where changes were already happening at the political, societal or technological level. In fact, philosophers like Wolfram Bergander argue that destructivity needs to be part of any work of art, and Pablo Picasso is also quoted to have said that painting is a "sum of destructions". Interestingly, while creative destruction in scientific terms can become evident rather early during the destruction phase – e.g. when a new scientific discovery is made – artistic movements and indeed artistic genius are often recognized as such in hindsight, when the movement has already had its peak or the genius is dead.

In the media, another recent example of an innovation that is destroying industries that are not adapting to this newly set standard is the rise of on-demand video-streaming as opposed to TV broadcasts: as of 2019, around 50% of US American people have chosen this kind of entertainment industry, while old-fashioned cable TV companies are steadily losing shares and video renting services are almost obsolete in the US: Netflix was one of the causes of Blockbuster's bankruptcy in 2010. This phenomenon is so evident that the phrase "Netflix effect" has been coined to indicate this type of creative destruction.

Finally, talking about popular Art, there is a video game inspired by creative destruction: <https://www.creative-destruction.com/>. Every element in this game can be destroyed and transformed into building materials with a special weapon called "Destructor". It is therefore possible to experience a full destruction-creation cycle while sitting comfortably at a computer!

Cultural References

In Hinduism, the idea of cyclic 'creative destruction' refers to the cosmological realm occupied by Shiva, whose continuous dance of creation and destruction governs the universe. There, the concept of creative destruction is also a never-ending cycle: Brahma, the builder, creates the universe; Vishnu, the preserver, takes care of the created, and Shiva, the destroyer, destroys it, so that Brahma can build it again. In other traditions within Hinduism, Shiva is also called Shiva Nataraja, the Lord of the Dance, and he is both the creator and the destroyer. As Reinert and Reinert (2006, p.59) put it: "His dance is the dance of the universe as it endlessly moves from creation to destruction, destruction to creation. It is in his nature to embody both, as one is not possible without the other."

Another cultural reference for creative destruction comes from ancient Greece. In these legends, the mythological bird phoenix rises from its own ashes. A long life and often death through incineration are part of the motif. This creation-destruction-creation cycle is a symbol of regeneration and renewal. Just like the process of creative destruction, it is never-ending. For the phoenix it is

also not clear where the cycle starts: does the creation follow the destruction, the destruction the creation, or is it a three-step process consisting of creation-destruction-creation or destruction-creation-destruction? The myth of the phoenix is therefore an interesting way of asking the question “what came first, the chicken or the egg”.

Such cycles of life, death and regeneration are sometimes considered allegories for eternal life. For example, by associating the phoenix with the repeatedly burned city of Rome, the Latin poet Martial alluded to Tibullus’s notion of Rome as the “Eternal City.” However, the cycles of creative destruction are neither rhythmical nor eternal.

Conclusion

This entry followed the historic and conceptual origins of creative destruction and provided a theoretical evaluation in the context of creativity. In particular, this entry focused on early descriptions of the principle by Marx and Darwin’s biological evolution, and at the popularization of the term ‘creative destruction’ by Schumpeter. The entry further illustrated the underlying principle by referencing similar ideas expressed in science and culture, from paradigm shift to the mythological bird phoenix.

By taking a step back, this entry discussed the theoretical relationship between creative destruction and creativity. In particular, the role of innovation as a trigger for disruptive changes leading to creative destruction posed a question that every reader might want to consider for themselves. Triggered by innovation, creative destruction propels a novel and useful idea into the market, and, at the same time, necessarily destroys an existing one. In current day societies, each established market participant is interlocked with the fate of employees, their families, and their communities.

If you held the key to such an innovation, would you deploy it for the benefit of the new idea and accept the destruction of others? Or to put it differently using a final example: There are thought experiments exploring the moral dilemma of steering your car to kill one person to save five others (Awad et al., 2018). Taking this example to the macroeconomic scale: Assume that technological development is inevitably replacing one car manufacturer in the near future. If you had the knowledge to significantly improve the next generation of individual transportation, would you share this and therefore accept the subsequent destruction of five existing car companies instead?

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Creative Environments, Conditions, and Settings[☆]

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Glossary

Audiences People who come in contact with the new ideas, pieces of art, literature, technology and science produced by creative agents.

Autonomously Creative People People such as artists, designers, garage inventors, writers, composers, and some academics who carry out much of their creative work beyond the walls of organizations and without the resources, supervision and structured work time that organizations usually provide.

Co-working Spaces Physical settings which offer a combination of individual and communal workspaces to autonomously creative people.

Creative Agents or Creators People who produce new pieces of art, literature, science, and technology.

Creative Cities Cities such as Paris, Milan, Tokyo, Vienna, New York City, San Francisco and Los Angeles which have been or are currently the site of noteworthy creative activity in particular fields.

Creative Environments Physical, social, and cultural environments which support and enhance the creative work of those who work and live within them.

Creative Seeds The initial “seeds” around which creative interests and activities sometimes develop. They often consist of newly encountered ideas, perspectives, images, sounds, objects, materials, processes, tools, or dream fragments which elicit the curiosity and attention of creatively-inclined people and which evoke creative activity.

Creatively-Active or Creatively-Engaged People People who are engaged in a creative project.

Creatively-Inclined People People who enjoys certain types of creative activity and who have a history of voluntarily, and often enthusiastically, engaging in those activities.

Designated and Protected Workspace A type of workspace that is “designated” in the sense that it is to be used primarily or exclusively as a person’s central place of creative work and is “protected” in the sense that it is not to be intruded upon, re-arranged, or “cleaned up” without permission. Such spaces may take many forms, including those of tables, desks, offices, studios, lofts, garages, basements, re-purposed factories, or capacious old barns.

Process- and Project-Entailed Challenges The psychological, material, and social challenges which creative processes and creative projects present to creatively-active people and the environments in which they work.

Introduction

Creative Environments

Creative environments help people function more creatively than they would in less creative environments. Because other entries in this Encyclopedia describe environmental factors which influence the creative functioning of people working within organizations and groups, this article will focus on environmental factors which often facilitate the efforts of autonomously creative people such as

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writers, visual artists, designers, and garage or basement inventors, who carry out much of their relatively solitary creative work without the support, supervision, or resources which organizations typically provide. Reflecting the availability of relevant scholarship and data, this article will focus on environmental qualities and features particularly relevant to writers and visual artists.

Working Assumptions

This article is organized around the assumption that creative activities and projects present a variety of challenges to people who attempt to carry them out and to the environments in which they attempt to do so. It is also assumed and implicitly predicted that environments which help people meet such challenges will tend to support higher levels of creativity than environments which do not. For example, because some (but not all) people require periods of uninterrupted focus while engaged in certain phases of their creative activities, environments which make it easier to maintain sustained focus during those phases would be expected to support higher levels of creativity than environments which do not.

As this hypothetical example suggests, however, creative agents are not uniformly sensitive to or affected by any given project-entailed challenge such as the need for sustained periods of uninterrupted focus. For example, some creators may not require such periods and may not require any special conditions to experience them. Therefore, although it may be possible to identify environmental features that are important for many autonomously creative people, it will not be possible to describe or characterize an environment that is apt to foster and support the work of all autonomously creative people, even those engaged in the same type of creative activity. In addition, the fact that different types of creative activities (e.g., writing a novel, painting a still life scene, producing a piece of pottery) undoubtedly present creative people and their environments with different sets of challenges, makes clear the impossibility of being able to describe the characteristics of a universally creative environment. Furthermore, in the absence of quantitative surveys or studies of presumably creative environments, most statements in this article regarding the importance or prevalence of certain environmental factors will be qualified by terms such as “some” or “many” but almost never as “most” or “always”.

Creative Episodes: Common Elements, Features, and Associated Challenges

This section was constructed by (1) compiling a list of widely-cited and presumably relatively common features of creative activities, (2) drawing inferences about the challenges those features present to people engaged in them and to the environments in which they work, and (3) drawing inferences about the functional characteristics of environments that would tend to help autonomous creators meet those challenges.

Motivation. People are motivated to initiate and carry out creative activities by a variety of anticipated and experienced pleasures and satisfactions. Some of these pleasures and satisfactions flow directly from the activities themselves, and others are contingent upon anticipated and actual reactions of the outside world to the created products. The first category would include, for example, the pleasures people often derive from using their own imaginations, from physically manipulating their projects’ materials, or from creating some new in the world. The second category would involve matters such as the recognition and praise the creative agents receive from their peers, as well as evidence that their work products have informed, given pleasure to, or in some way benefitted those who come in contact with them. Most professionally creative adults who are financially responsible for themselves and others are also motivated by the hope that their creative work will enhance their financial well-being.

The nature of these motivations poses three challenges to the environments in which autonomous creators work. (1) Creative environments should contain or make possible the creation of workplaces in which process pleasures can be fully experienced. (2) They should contain relevant “audiences” who are able to derive or create value from the agent’s products and are capable of rewarding those who produce them with praise, recognition, monetary support, and opportunities for future work. (3) They should also contain people, social systems, and infrastructure (e.g. agents, editors, publishers, bookstores, and galleries) that help bring new products to the attention of such audiences. Environments which serve these functions well should support higher levels of creative activity than environments that do not.

Creative Seeds. Creative activity is sometimes triggered when creatively-inclined people come in contact with creative seeds. Seeds sometimes take the form of invitations, competitions, or commissions relevant to a creatively-inclined person’s creative interests. In other cases, creators decide to undertake projects which are available in the social or artistic-intellectual milieu as tasks and which are considered to be interesting and important tasks. Examples include writing the “Great American Novel,” writing an essay explaining in convincing detail how consciousness arises from activities of the brain, or producing a piece of art that captures the essence of the times.

More commonly, however, independent creators construct their own projects from what may be thought of as creative “seeds” which re-ignite and are assimilated to their ongoing creative interests. Seeds may come in the form of new ideas, images, sounds, objects, materials, processes, tools, and ways of thinking which are encountered in the outside world. The impact of Picasso’s contact with African art and masks nicely illustrates this phenomenon.

As a more prosaic example, a snippet of conversation overheard on a busy sidewalk or in a check-out line might become the seed for a new song, detective novel, piece of art, or nothing at all, depending upon whether it was overheard by a singer-songwriter, a writer of detective novels, a visual artist, or by someone who is not at all creatively-inclined. Creatively-inclined people also sometimes experience seeds emerging in the form of dream fragments or compelling feelings, ideas, or feelings which suddenly manifest themselves in consciousness. In other instances, creative seeds emerge from explorations and playful manipulations of the materials with which people are working.

The importance of seeds presents creatively inclined people with three challenges: (1) to place themselves in informationally and sensorially rich situations where they are apt to encounter new seeds; (2) to place themselves in or create settings in which internal seeds are apt to arise; (3) to place themselves in or create settings in which they are able to engage in the goal-free explorations and playful manipulations of the materials from which seeds often arise.

The corresponding challenges for environments are (1) to contain a rich panoply of seeds and (2) to contain settings or situations conducive to the emergence of “internal” seeds, and (3) to provide settings in which goal-free explorations and playful manipulations of their materials are possible and permitted.

Spaces and Places. The creative activities being considered in this article must take place in 3-dimensional spaces. In some cases these spaces may involve little more than a place to sit and write, although in other cases these spaces may involve larger and more complex spaces in which special materials and equipment can be stored and used. The challenge to creative environments is to contain such spaces and to make them available or to make it possible for people to construct them. The challenge to autonomous creators is to locate or construct them.

Some people and some creative activities (e.g., plein-air artists, certain writers) require or prefer outdoor spaces in which to work. Such spaces are often relatively quiet and solitary, frequently contain visually interesting vistas, are often located in appealing natural settings, and typically permit sustained and un-interrupted absorption in the task at hand.

Time. Creators typically would like to spend as much time as necessary on their projects and often wish to exercise considerable control over how their work time is configured. For example, some creators can or must work effectively in many short blocks of time whereas others need long periods of time. Some creators also have very strong preferences regarding the time of day, week, or even year and, in which to work. Some creatively-engaged people want to be able to plunge quickly into their creative work in response to suddenly emerging ideas or to a strong sense that they are really ready to work.

The challenge to these people is to find or “make” such time for their work and to find ways to control the configurations and availability of that time.

The corresponding challenge to creative environments is to help people find or make adequate work time and give them the freedom to configure and access that time as needed.

Reliance Upon Easily-Disrupted Concentration

I find it is very important to work intensively for long hours when I am beginning to see solutions to a problem. At such times atavistic competencies seem to come welling up. You are handling so many variables at a barely conscious level that you can't afford to be interrupted. If you are, it may take a year to cover the same ground you could cover otherwise in sixty hours.

Edwin Land, inventor of the Polaroid camera, quoted in *Bello (1959)*, p. 158.

As illustrated by Edwin Land's comment above, and as echoed by many others, some creators need protracted and uninterrupted periods of time during which they can become totally absorbed in their work without fear of being disrupted.

The challenge to people who have such needs is to create or locate time and space in which such uninterrupted absorption and concentration is possible. The corresponding challenge to creative environments is to provide the space and time necessary for such periods of uninterrupted concentration.

Reliance Upon Experimentation, Exploration, and Partially-Guided Trial and Error

People in many fields often find themselves relying upon experimentation and partially-guided trial-and-error during certain phases of their creative activities. Although some creators enjoy these processes, others are made anxious or embarrassed by their uncertain effectiveness. As a result, some creatively-engaged people are very resistant to having people looking over their shoulders as they work.

The challenge for creative people is to understand and manage such feelings and fears sufficiently that they do not disrupt their work. The corresponding challenge for creative environments is to help creators understand and manage such feelings and help protect them from unwanted observation.

Reliance upon non-conscious cognitive processes. Creators sometimes experience their work as being dependent upon the functioning of cognitive processes which are largely beyond their conscious awareness or control and which may or may not produce useful ideas. In some instances the products of these non-conscious processes appear unexpectedly in consciousness while people are engaged in relatively mindless and often relaxing everyday actions such as taking showers, napping, or falling asleep. Creatively active people have sometimes found leisurely strolls, especially those taken after lengthy or intense periods of creative work, useful in this regard. In other cases, people have attempted to consciously access these rather elusive processes by establishing what they consider to be particularly helpful external conditions which are often characterized by lack of distractions and a sense of peace and quiet. Reliance upon these marginally-controllable and unpredictably effective processes can also stir feelings of anxiety and self-doubt similar to those elicited by reliance upon experimentation and guided trial and error.

The challenge to creative people is to arrange external and internal conditions which facilitate conscious contact with the products of these non-conscious processes and to understand and manage the anxieties sometimes associated with reliance upon them. The corresponding challenge to those who manage creative environments is to help make such times and places available and to help people understand and manage the feelings of anxiety and self-doubt sometimes associated with dependence upon these processes.

Physical materials and tools. Many forms of creative activity require the use of certain physical materials, tools, and instruments such as specialized paints and brushes, appropriate clay and glazes, potters wheels, and kilns. The challenge to creative environments is to contain and provide access to such materials and tools and the challenge to creative people is to gain access to them.

Assistants. Creative activities initially undertaken as one-person projects sometimes require more knowledge and specialized skills than one person can provide. The resulting challenge to the creative agents is to accept their need for assistants and to locate and recruit them. The corresponding challenge to creative environments is to help people identify and accept their need for assistance, to contain and provide easy access to relevant assistants.

Solitary activity. Many autonomous creators work in settings in which they have little or no contact with other people for several hours at a time. Although this solitariness suits some people very well, and may in fact be one reason they have gravitated to these activities, the solitariness may be problematic for more extraverted people. The challenge to creative environments is to provide opportunities for solitary creators to engage in social interactions as desired.

Tentative completion. Creative projects must eventually be brought to initial completions despite the imperfections and undeveloped possibilities that are often disturbingly evident to those who created them. The challenge to creative people is to complete their projects despite uncertainties as to whether they are good enough to submit to the wider world. The corresponding challenge to creative environments is to contain peers or experts who can help creators make good decisions about when to consider a project finished.

Projection into and reception by the outside world. If creative products are to provide those who create them with the socially-contingent benefits they need and desire and if the products are to benefit people for whom they were created (their intended audiences) they must be projected into the outside world and made visible to audiences that are capable of recognizing, rewarding, and responding to them in motivationally satisfying and practically valuable ways. The challenge to autonomous creators is to find ways by which their finished projects can be brought to the attention of such audiences. The challenge to extended creative environments is to: (1) contain audiences which are able to derive or create value from those new products and are able and willing to direct psychological, social, and monetary resources back to the original creative agents and to those who helped bring the products to the attention of the relevant audiences, and (2) contain intermediaries (e.g., agents, publishers, gallery owners) and social systems that help bring new products to the attention of such audiences, and (3) contain social mechanisms by which appreciative audience members are able to directly or indirectly reward those who created the valued products and to those who brought the products to their attention.

The challenge to creators is to be flexible and extremely persistent in trying to push their work into the world. It is worth noting that J. K. Rowling's efforts to solicit interest in her initial *Harry Potter* drafts were rejected by 12 publishers before finding one that was receptive. Books and online columns directed to artists, especially young artists, consistently recommend persistence in the face of rejections by juried shows, galleries, and other gatekeepers that are preventing their work from being seen.

Characteristics of Sought-Out and Constructed Environments

The actions taken by autonomously creative people to seek out and construct creative environments for themselves constitute another interesting source of information regarding the nature of creative environments. Descriptions of those actions and the nature of the sought-out and constructed environment have been reported by autonomously creative people themselves as well as by journalists, biographers, sociologists, and historians. The following topics are frequently mentioned in these descriptions:

1. Designated and protected workspaces.
2. Socially permeable and familiar workspaces.
3. Writers and artists groups, clubs, collectives and cooperatives.
4. Artists and writers colonies and retreats
5. Creative cities and neighborhoods.
6. Supportive spouses, partners, and friends.

Designated and protected workspaces. Many autonomously creative people involved in relatively solitary activity construct or seek out primary places of work which may be described as "designated and protected" workspaces. These spaces take many forms, including that of tables, desks, offices, backyard studios, garages, basements, lofts, work-live spaces, barns, re-purposed warehouses, and secluded cabins. These spaces are "designated" in the sense that they are intended to be used primarily or exclusively as the person's central place of creative work. They are "protected" in the sense that those who use them often make clear to other people that the spaces are not to be intruded upon, re-arranged, or "cleaned up" without permission. The "protected" quality of these spaces certainly calls to mind Virginia Woolf's famous suggestion to aspiring young women writers that they should manage to obtain rooms of their own "with a lock on the door" (Woolf, 1929).

Some creators also try to make these work-spaces quickly accessible by establishing them within or very near the structures in which they live, though others find it easier to maintain the designated and protected quality of these workspaces if they work elsewhere. Ideally these spaces can be equipped and arranged to suit the user's work style and preferences for such matters as décor, lighting, and the presence or absence of background music. Such workspaces serve many functions in the process of supporting their users' creative activities.

Help sustain uninterrupted work. For many creators, the most valuable aspect of such spaces is the fact that they provide the physical and psychological space needed to engage in the uninterrupted and undistracted periods of absorbed, concentrated, and sometimes meditative thought which are so often crucial to their creative work.

Encourage and support self-imposed work schedules. The existence of designated and easily accessible workspaces also appears to encourage some creators to begin their work on self-imposed schedules, a function which organizations often provide people working within them but which autonomous creative agents must provide themselves.

Preserve work-in-progress. By permitting people to leave work-in-progress (e.g., unfinished canvases, pages ending in mid-sentence, partially completed gadgets, etc.) safely undisturbed between periods of work, these work-spaces reduce set-up time, but more importantly, help people quickly re-enter their previous frames of mind and easily pick up threads of thought which were laid to rest at the end of their last period of work.

Safe space for small "failures". Such settings also function as psychologically "safe" spaces in which it is possible to engage in the frequently unsuccessful experiments, explorations, and partially-guided trials-and-errors so often characteristic of creative work without fear of having others witness these many small "failures".

Motivational support. Such workspaces sometimes provide modest motivational support and encouragement in at least three ways. Because they can be arranged to meet the creative worker's individual tastes, they can enhance the pleasure experienced while working within them. In addition, if such spaces are used almost exclusively for creative work, the simple act of entering them may sometimes trigger the kind of focused creative work that has come to be associated with that space. Furthermore, if these spaces have been the site of previously successful work, they may reduce project-related anxieties by eliciting memories of those earlier successes.

Accessible materials and tools. Such work-spaces facilitate creative work by making the necessary materials and tools and often specialized information easily accessible.

Exceptions; It should be noted, that some very fortunate and flexible writers have reported that they can work anywhere they can physically write and therefore need no special places in which to do their work.

Socially permeable and familiar workspaces. Designated and protected work settings do not meet the needs of people whose circumstances prevent their using them such as parents who must work within sight and sound of people who they caretaker. J. K. Rowling, for instance, famously wrote parts of her first Harry Potter novels sitting in a neighborhood cafe with her infant resting in a nearby stroller, and a coffee machine moments away.

Familiar coffee shops, cafes, restaurants, and local libraries. Designated and protected workspaces also don't meet the social needs of people who find them too isolating. As a result autonomously creative writers who need to work in more social settings often turn to familiar and accommodating coffee shops, cafes, restaurants, and local libraries as places to work near other people. For decades, autonomously creative people in Europe and the United States have used cafés, bars, and restaurants as places to work as well as places to meet and mingle with one another, typically at the end of their frequently solitary workdays. The café life of Vienna and Paris, for example, has often been cited as an important factor in sustaining the creative ferment of these two cities. Historians and sociologists of art and literature have also cited the roles played by particular bars in the emergence and development of bebop jazz in Harlem in the 1940s, the New York School of artists and poets in the 1940s and 1950s, and the development of the beat poets in San Francisco's North Beach in the 1950s. In such settings creative people are able to satisfy some of their needs for social contact. Here, too, they are able to participate in conversations and creative interactions with other creatively-active and intellectually-lively people who expose them to new and, perhaps, the very newest, ideas, perspectives and methods in their field of work. Valuable information about possible venues and outlets for their work and about intermediaries who might help project their work into the larger world is also sometimes exchanged and in these conversations. Within such gathering places, autonomously creative people also sometimes experience implicit affirmations regarding the importance and ultimate value of the kind of work in which they are engaged as well as more personally-directed expressions of encouragement and advice.

Co-working spaces and writers rooms. Recent years have seen the emergence of increasing numbers of co-working spaces which serve some of the physical and social needs of autonomously creative people. These co-working spaces, (or "writers rooms" in the case of those exclusively serving writers) typically offer private and semi-protected workspaces as well as communal spaces that can be used to socialize and exchange information relevant to their work. Some co-working spaces include communal spaces that have been specifically designed or configured to facilitate potentially synergistic exchanges of information and possible collaborations between creatively-active people working in different fields.

Informal groups and clubs. Autonomously creative people also seek creative support and stimulation by creating or joining local writing or artists groups in which they can share work-in-progress, explore thoughts regarding possible future projects, and receive constructive critiques in supportive environments.

Collectives and cooperatives. Autonomously creative artists sometimes attempt to facilitate their own work by affiliating with artists' collectives and co-operatives. In such settings artists are able to share space, materials, equipment, ideas, perspectives, and experience what they often describe as "good energy".

Artists and writers colonies. Every year, thousands of autonomous artists and writers apply to attend one of the hundreds of artists and writers colonies located in the United States. The qualities of some of the most prestigious of these colonies such as Yaddo in New York and MacDowell in New Hampshire, reveal much about the kind of working environments which many, though not all, independent writers and artists desire. In both of these colonies artists enjoy 24-h access to designated and protected work-spaces in the form of appropriately-equipped studios. Lunches are typically delivered to the individual cabins or studios in ways designed not to interrupt work. Relieved of almost all

non-work-related responsibilities and distractions and provided with designated, protected, and well-equipped workspaces, residents are able to focus essentially all of their energy and attention upon their creative work. Communal dinners and gatherings in the evenings provide opportunities for residents to socialize, exchange ideas, and share work in progress. Though such colonies do not fit the needs of all autonomously creative people, due in large part to the separation from family they require, and though access to such colonies is sharply limited, the appeal they hold for many autonomously creative people is instructive.

Creatively-active cities and neighborhoods. In seeking creative environments in which to live and work, autonomously creative artists and writers are sometimes drawn to cities and neighborhoods that are heavily and often unusually densely populated with people involved in creative activities similar to their own. As mentioned earlier, Paris, New York, San Francisco, and Los Angeles are famous examples of such cities, although they are certainly not alone in this respect. The following reasons explain why certain cities function as magnets for creatively ambitious people as well as serving as incubators and sustainers of their creative work.

Populous, culturally diverse, and historically and contemporaneously supportive of the arts. Such cities typically contain:

- large numbers of other creators with whom ideas and enthusiasms can be shared,
- affordable spaces in which to live and work
- rich supplies of necessary and sometimes specialized materials
- potential assistants who have specialized skills
- patrons, benefactors, and sponsors who are interested in supporting autonomous creators.
- diverse and sophisticated audiences eager for new creative products.
- sophisticated intermediaries such as critics, talent scouts, and agents who are interested in identifying producers of new and creative work and connecting them and their work with relevant audiences
- numerous outlets and venues such as galleries, bookstores, exhibition halls, and public readings by which new creative work can be displayed to relevant audiences and potential patrons;

Informationally-and-sensorially rich cross-roads. These unusually creative cities also tend to be cross-roads through which people from many countries, cultures, and traditions frequently pass and destinations and to which they sometimes come to live and work. In so doing such people bring steady streams of creativity-relevant information and creative seeds in the form of new ideas, values, knowledge, images, colors, sounds, tastes, tools, and ways of thinking and doing things.

Attractors of creatively talented and ambitious people. Because of their creativogenic qualities, these cities tend to continue attracting creatively-talented and ambitious people from across continents and oceans, thus swelling the numbers of creatively-inclined people living and working in relatively close proximity to one another. Such increased numbers and densities tend to increase the likelihood that creative neighborhoods emerge, that planned and unplanned interactions among creatively-active people occur, and that ideas, enthusiasms, materials, work-spaces, and gathering places might be shared. As a result of these processes, of course, such cities tend to foster ever higher levels of creativity and become even more attractive to creatively ambitious people who might gravitate toward them. At certain points, however, such cities may become so saturated with people engaging in certain types of creativity that their capacity to support and attract new creators in certain fields wanes.

Creative cities not for all and not necessary. Autonomously creative people certainly do not need to live and work in creative cities to do their creative work. In the first place, many people simply do not like cities as places to live or are prohibited by practical considerations from doing so. In addition, many creative people do not wish to lose their sense of place, comfort, and belonging by moving to a city. Others do not want to be distracted from their work by the many seductive possibilities that cities offer, to become overly influenced by the highly visible and much-talked-about creative work of other people, or to experience themselves as little fish in big ponds.

Autonomously creative people have also begun reporting that new modes of communication and new ways of displaying and advertising their work made possible by the latest technologies are diminishing some of the creative advantages previously afforded by physical proximity to creative colleagues, potential patrons, audiences, and intermediaries. Many autonomously creative people are able to find and establish good working environments and creatively supportive local environments in smaller cities and towns. For example, writers groups and artists co-operatives can be established almost anywhere that a few similarly-intentioned writers and artists reside.

It should also be noted that many creative people who are attracted by some of the benefits of unusually creative cities but deterred by others, resolve their dilemmas by locating themselves outside of but within easy reach of such cities.

Supportive spouses, partners, and friends. In any location, supportive spouses, partners, and friends often play important roles in the lives and work of autonomously creative people. For example, autonomously creative people often acknowledge the important role played by people with whom they live in helping to establish and protect their workplaces. Spouses and partners are also often thanked for tolerating work patterns that sometimes deviate substantially from the social norm, by occasionally freeing up work time by relieving the creatively active person of some household obligations, and by tolerating problematic behaviors and mental states sometimes associated with intense involvement in creative activity. Spouses, partners and friends are also frequently identified as influential sources of personal encouragement and as people who affirm the fundamental value and importance of the kind of creative work being done. In some cases spouses and partners also serve as sounding-boards, first audiences, helpful critics, and friendly editors.

Caveats

Variability among good creative environments. Creatively-inclined people differ from one another in many respects. As a consequence, the environments and settings within which they will flourish creatively undoubtedly differ in ways that reflect those individual differences. As noted earlier in this chapter, for example, the conditions preferred by easily and not easily distractible people or by relatively extraverted and relatively introverted people may differ in substantial ways. Furthermore, the conditions, settings, and environments supportive of one type of creative activity, such as writing a novel, may not be most supportive of other types of creativity, such as producing a series of thematically related canvases or pieces of pottery. As a consequence, the environmental conditions most helpful to any particular creator working on any particular project may not be the most helpful to other people working on other projects. This suggests that the ideal macro-environment for creative people is probably one within which autonomously creative people have the freedom to migrate to or construct whatever particular environments best suit their individual- and project-specific needs.

Many of the varied environments constructed or sought out by autonomous creators would exhibit at least some of the environmental features and functions described here. The degree to which this proposition is true for autonomous writer and artists, of course, remains to be seen, as does the degree to which the analyses presented here generalize to other types of creative activity.

Creative Environments Helpful but Not Necessary

It is extremely important to recognize and emphasize the fact that very good environments are neither necessary nor sufficient for creativity to occur. As history shows, acts of creativity can and do emerge from very difficult or even hostile conditions, and as history also shows, creative efforts undertaken in highly supportive environments often fail. Although supportive environments are neither necessary nor sufficient for creativity to occur, it seems reasonable to suppose that they tend to increase the likelihood that creative activities will be undertaken and completed successfully within them. Establishing and seeking out creatively supportive environments may therefore be analogous to eating well, exercising, and not smoking. While such practices do not guarantee good health or long lives, they generally improve the odds. Given the inherent complexity and unpredictability involved in creativity, that seems all that could be hoped for.

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Creativity and Destruction

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The term destruction describes damage beyond recovery or repair, changing something into a state of non-existence. Through creation, on the other hand, something emerges that did not exist before. This fundamental distinction is, at least, the understanding one can get from consulting dictionaries and common language texts. The term ‘Creativity’ with its different notions and definitions is not discussed here (See Definitions of Creativity). However, it is important to note that creativity entails more than creation, for example it also has to provide value. Authors like Novitz (1999, p. 78) and others have argued that those who are ingeniously destructive cannot be described as creative. Furthermore, the technical term ‘Creative Destruction’ is closely related and discussed in more detail in a separate entry in this volume. Here, the focus is on the relationship between creativity and ‘destruction’.

Etymologically, destruction derives from the Latin ‘struo’ prefixed with ‘de’. ‘Struo’ has meanings similar to building, preparing, and arranging but the prefix ‘de’ reverses that meaning. The root also appears in words with other prefixes; in this context, most notably with ‘co’, which then takes the meaning of collecting, fabricating, and constructing. Therefore, the dichotomy of the “Creativity and Destruction” is already reflected in their linguistic root. For example, in the building industry, construction and destruction are used to describe opposing processes; one putting a new building in place, the other eliminating an existing structure. However, what is the meaning of destruction beyond its use in everyday language?

Destruction

The use of ‘destruction’ in the philosophical literature appears in Heidegger’s use of ‘Destruktion’ as destroying ontological concepts (see a discussion of the term in Botha, 2008). In his writing, he argues that ‘destruktion’ is necessary to overcome a tradition that is only self-evident and whose source is inaccessible to us. He posits that this ‘destruktion’ has a positive intent by deleting the ontological concepts of the past and therefore giving way to a better and contemporary understanding. Interestingly, the use of the term itself appears to be influenced by Martin Luther’s work. For example, Crowe (2006) argued that Heidegger’s introduction of the concept references the Latin source of the word in a similar way that Luther did and how it was sketched above. Moreover, Heidegger seems to reference Luther directly in his texts, which suggests that, even if it had not directly influenced the use of the term, Heidegger at least knew about it.

In an attempt to translate Heidegger’s concept of ‘destruktion’ to French and apply it to understanding linguistic concepts, Derrida introduced the term ‘deconstruction’. Based on the fundamental understanding that words only have meaning through their difference to each other, the term suggests that after taking apart its pieces, there is still something left.

Deconstruction influences theories in a broad range of disciplines beyond the scope of linguistics, such as in architecture, anthropology, and humanities and shares this interdisciplinary relevance with creativity. However, according to the reading of Gasché (1987), Derrida’s deconstruction is a “well-ordered procedure, a step-by-step type of argumentation” (page 3) which sets it apart from the sudden and often unexpected nature of creativity. In its step-wise progression, deconstruction more likely compares to well-structured analytical thinking, than to free-flowing creative outbursts. Therefore, Heidegger’s destruction, aiming at annihilating the underlying ontological concept, might be a better candidate to consider as an antonym for creativity.

Another seemingly related term is the notion of destructiveness was used by Fromm (1973). He observed that people either embrace or escape freedom and further identified three mechanisms for escaping freedom. Destructiveness, as one of them, refers to the withdrawal from the world by eliminating it. Instead of exploring or enacting freedom in the world, this destructiveness causes people to destruct everything else. While destruction and creativity share common factors such as their role across interdisciplinary settings, they appear to be principally dissimilar in their mechanisms of operation and their outcomes.

Creativity and Destruction in Literature and Art

In his magnum opus “Faust”, Goethe let Mephistopheles (the Devil) introduces himself with the words:

A portion of that power, Which wills the bad and works the good at every hour.

When asked what that is supposed to mean, Mephistopheles explains:

And so, then, all that you call sinning, Destruction,— all you pronounce ill-meant,—Is my original element.

and goes on explaining that this element has been a necessary and integral part in this world since its creation. Going beyond the simple dichotomy outlined above, Goethe contrasts creation and destruction as opposite ends of a scale, as well as naming them integral parts of the same force. Dr. Faust, the protagonist and a scholar whose search for truth brings him not only to the edges of science but also to social norms, makes a deal with the devil. They agree that Mephistopheles will reveal the desired knowledge to Faust until he is satisfied, and the Devil will earn Faust’s soul in return. Throughout the first part of the play, they explore the immediate and contemporary environment of Faust while in the second part, they explore the macrocosm and time itself.

‘Faust’ has been translated in many languages and has had a great impact on artists and researchers since its publication. Mikhail Bakunin, a Russian political writer as well as anarchistic theorist and activist, was well acquainted with Goethe’s works. When he wrote about the power of negation as a revolutionary act in his 1842 essay “The reaction in Germany”, unmistakably there was a connection to Goethe’s Mephisto: “Let us therefore trust the eternal Spirit which destroys and annihilates only because it is the unfathomable and eternal source of all life. The passion for destruction is a creative passion, too!” It was later paraphrased to “The urge to destroy is also a creative urge” and attributed to Picasso, for example by Banksy, a street-artist commenting on his intentional destruction of “Balloon Girl”, through which it was transformed into “Love is in the bin”.

Examples from performing arts and music might be even more obvious. Stage productions in theaters around the globe have de(con)structed plays on several levels, from the aesthetics of classic stagings, to the prose and the method of acting. Choreographers have destroyed the social link of dance with its formalization in ballet and destructed this performance dance with improvisation and dance theater. Musicians have destructed their precursors works and music itself for a long time. Most notably, Johann Sebastian Bach destructed his own compositions in trying to understand the science behind music, and even recombined identified elements to new pieces. With sample-based musical styles consisting of excerpts from other recordings, Jimi Hendrix’ and Kurt Cobain’s destruction of musical instruments and styles that challenge any previous listening customs, the musical industry provides a broad range of examples for destruction. As such, the contrast between destruction and creativity so often portrayed in art and literature begins to reveal the complexity of the relationship between the constructs, as well as our interest in their tangled association.

Creativity and Destruction in Science

The trajectory of science is often depicted as a continuous progression from the early observations of natural phenomena to the discovery of the Higgs boson, and from belief-driven communities to managing complex social systems. At most, certain discoveries, such as Newton’s understanding of gravity, are considered sudden leaps forward. Yet, this is only part of the history of science. To follow, if you will, the fall of the Newtonian apple through history, Albert Einstein saw a problem of aligning the laws of the electromagnetic field with Newtonian mechanics. His work can not only be considered a creative leap forward, but at the same time, his paper on general relativity was a destruction of a previous theory. With his work, he catapulted the discipline, Physics, into the second revolution or ‘new Physics’. Interestingly, Einstein’s rejection of the possibility that measuring one particle could affect a second through “spooky actions at a distance” (as he noted in a letter to Max Born) had to be destructed as well, to understand entangled quantum states.

Looking at the history of science, Max Planck’s observed “A new scientific truth does not triumph by convincing its opponents [...] but rather because its opponents eventually die” (often paraphrased as “science advances one funeral at a time.”). This hyperbole shows some similarity with Heidegger’s ‘destruktion’. And indeed, generalized into the philosophy of science, Karl Popper defined science as testable. Specifically, he stated that every test of a theory is the attempt to falsify it. According to his framework, science must be falsifiable and every new prediction or theory needs to prohibit things to happen as well as provide a possibility to falsify it. As a more contemporary example, Stephen Hawking followed up by theorizing that a single disagreeing observation necessarily disproves a theory, and therefore advances science itself. Consequently, science in its definition and theorization, does not relate to creativity. Rather, destruction enables scientific progress and the scientific way of enhancing knowledge is through the falsification of testable hypotheses. To exaggerate, science would be indistinguishable from dogmatic belief-systems if it was not for destruction in the form of breaking mental sets and falsification.

Aspects of Destruction

From the discussion so far, it seems that destruction and creativity appear to be on opposite ends of the same scale yet additionally linked in other ways. Destruction and the closely related concept of deconstruction, are not creating anything novel and useful, rather they remove or “un-create” something. But as is clearly depicted in the wide range of articles in this Encyclopedia, creativity encompasses many different dimensions.

In the 1960s, Rhodes distinguished between different aspects of creativity that should be considered when doing research, or rather suggests that any research can be considered to be either about a creative person, creative product, creative process, or creative press (Rhodes word for environment that started with ‘p’). Later Simonton and Runco extended these categories to persuasion and potential. Building on these concepts, Glăveanu (2013) suggested another terminology that addresses the same underlying ideas but emphasized creativity as part of a social system. He talked about artefacts, affordances, audience, actors, and action. The advantages and problems of these terms are discussed elsewhere, but what would happen, if these same categories were applied to destruction instead of creativity?

In that sense, a destructive actor has a negative connotation and refers to active people with challenging personality traits. They can have negative consequences for other actors as well as any of the other four categories. Often this means, that they criticize others in the best case or attack them in the worst case. Depending on how this person is enacting this destruction, this can have a number of consequences. For one, critique usually leads to a better overall result, because the people critiqued will try to find a way to respond to the attempted destruction. Secondly, any attack will lead to a defense, and if the defended idea outlives the attack, then this stands a test of time. In some sense, and borrowing terminology from evolutionary studies, the destructive person provides a fitness function for the creating person. Furthermore, to be truly and impactfully destructive, this requires novel and useful ways of attacking others.

A destructive artefact is an item that can be used to destruct other things. One very effective and prominent example is the atomic bomb. Its development required many creative actors and creative affordances. Despite its cruelty and detrimental political and environmental impact, it is, without a doubt, a creative and a destructive artefact. The same could be said about many other inventions and technologies humans have developed over the years.

A destructive audience is an audience that destroys an artefact. One example could be the person consuming a dish of a master chef. Even though the artefact is destroyed afterward, this is the purpose of it in the first place. Another example is a piece of art that is destroyed through the interaction with the audience. A very slow destruction are visitors in a castle or visitor center, whose presence alone wears away the steps in the staircases, and whose humid exhaustions provide a challenge to the observed artefact. Yet another example is the piece of art by Banksy that destructed itself the moment it was sold at an auction. By the unintended and unwanted consumption as a commercial product, the piece of art destroyed itself. In this particular case, it attracted even more attention, and some argued, that the destruction itself increased the value of the artefact. Certainly, the self-destruction was a creative answer to a certain problem in the creative industry. Similarly, audience unintentionally destructed the career of their favorite music bands in some cases, when the audience became too big and the music groups disbanded as a response to this. For example, ‘The Jimi Hendrix Experience’ famously disbanded in 1969 as a result of commercial success and reduced artistic freedom. While Jimi Hendrix explored different directions with the ‘Band of Gypsies’ while also reforming with the ‘Experience’ several times, this success was arguably the beginning of a descent even quicker than their rise to fame.

A destructive affordance could be the intentional or unintentional harmful environment in which many people live. A great range of examples illustrate that these situations can lead to creative ways of coping with them. East German musical groups, that were not allowed to freely speak up and feared censorship, occupational ban, or even jail, developed a whole set of harmless and misleading metaphors that they used to communicate their opinions. Survivors of hurricanes and other life-threatening situations have used artefacts in a creative way to manage highly destructive situations.

The Creation and Destruction of Norms

Having briefly explored the idea of the “destructive actor”, the following section focuses on how individuals might destroy norms in order to create or to be deemed creative. Previous research has argued that in order to be creative, or more specifically, in order to engage in divergent thinking, individuals are often required to break rules. It does not seem too ambitious to say that in order to *think outside of the box*, an individual might have to break free from a set of rules which usually guide their thoughts and behaviors. Take the artist who begins to experiment with new styles and techniques in their work, later resulting in the creation of new genres. In fact, the emergence of Cubism in the 20th century might be traced back to Picasso’s and Braque’s early experimentation with fragmented and abstracted objects, which deviated from existing techniques that focused on perspective drawing. However, these examples of breaking rules are not restricted to the arts, as the following examples from business contexts demonstrate. Take the innovators who setup low-cost airlines like Ryanair and personal transport companies like Uber. They challenged the established ways that major transportation operators ran their businesses and changed the rules of the transportation game. Globally, businesses and institutions are seeking these kinds of individuals; people who will “take risks” in order to find or create innovative ways to solve problems and so the demand for rule-breakers is high.

Nevertheless, is it not inappropriate to search out, praise, and reward rule breakers? Without basic rules, there would be chaos. Many *social norms*, the unwritten and informal criteria that govern the behavior of a group, have developed for good reasons. Although closely linked, the term “norm” cannot be interchanged with “convention” here. Conventions come with empirical expectations about how they should be followed. For example, a conventional “cream tea” in Cornwall (England) would be served to you in the form of scones with jam, Cornish clotted cream, and a hot cup of tea. You would probably be surprised if you were served an unconventional cream tea that comprised bacon and eggs instead. Social norms are more prescriptive in that they involve normative expectations, as well as empirical ones. So, spreading jam and clotted cream onto the scone with hands, rather than a knife, would probably offend observing people. While violating this norm of etiquette does not damage the welfare of someone else specifically, the act damages the reputation of the person who appears to not care about this social norm.

One could argue that social norms keep group members in check and stop them from crossing perceived boundaries and therefore potentially bringing harm to the group. Community members share these norms and maintain them through sanctions. For example, it would be considered inappropriate to use swear-words in public in many cultures. If someone were to go into the street and start yelling obscene phrases, this act would most likely offend people. Most members of a group would avoid behavior like this because of the disposition to conform to this norm; they would feel guilty and ashamed if they swore in public. Society would actively sanction the inappropriate use of swear words by others, and individual members are motivated to ostracize those individuals who choose to use indecent language. The reverse is true as well: certain subcultures require the use of codes and languages that would be inappropriate in other contexts. Not complying with these expectations is a similar breach of social norms within that particular culture.

However, this is not to say that all social norms lead to good outcomes for society. Many negatively perceived social norms exist across communities and can be detrimental to the wellbeing of group members. Consider how gender norms (social norms that relate to gender specifically) can influence thoughts and behaviors. The *empathic boy* or the *risk-taking girl* might not fit with long-held gender norms and unfortunately, this can hinder personal and professional progression and can lead to the development of detrimental stereotyping. Along with the prejudicial effects that social norms can have, the relationship between social norms and creativity can be paradoxical. Even when social norms are beneficial in maintaining society’s foundations, the predictability and stability with which they regulate behaviors might make them detrimental to creativity. For example, when people collaborate to make a creative product, they often conform to ingroup norms. However, when working individually, they may deviate from the ingroup norm and create novel artefacts. In environments that become predictable and stable, that do not encourage originality or innovation, institutions operating in an innovation-driven society favor non-conformists, willing to bend or break the rules who can produce creative outputs.

Given that rule breakers can produce these creative outputs, isn’t it right that they be sought out, praised, and rewarded? Perhaps this complex question can be addressed using a cost-benefit analysis. Do the benefits of breaking a rule and not conforming to a norm, outweigh the costs of destroying certain boundaries? Consider an example from academic and research contexts. Academia, at least in the western countries, has developed into a multitude of disciplines in the past century. Each of the disciplines has adopted a specific set of methods and terminology to communicate about the subjects of interest effectively. Alongside this, each scientific community has their own set of *social norms*. In recent years, multiple disciplinary publications gained considerable attention and had some impact across scientific communities. Currently, funding bodies support multiple disciplinary grant applications and expect involved scientists to research across disciplinary boundaries and consequently *break the social norms*. In interdisciplinary research, the cost is represented in communication difficulties and the additional work of integrating methodology stemming from different disciplinary backgrounds. Most obviously, this results in additional time required.

The benefit, on the other hand, is the possibility to address more complex research questions from a different perspective. One example from the academic world, was an interdisciplinary doctoral training center ‘CogNovo’ at the University of Plymouth. Research about the iterative emergence of novel and useful ideas on perceptual, individual, and system-level (dubbed ‘Cognitive Innovation’) was addressed from a range of disciplines. The above-average time to completing the PhDs and high-impact publications illustrate the two outcomes of the cost-benefit analysis. Valve, a gaming company, could serve as another example in the industrial domain. At some point, they abolished teams and hierarchies and gave their employees ownership over their products along with the freedom to work with anyone and physically move their desk to any location. The intention was to cross professional boundaries that traditionally belong to different teams to allow people to work together. For example, designers could directly interact with coders, and someone from marketing would be able to work with a mathematician developing the game engine. Similar cost-benefits are very apparent in this case as well, as Valve had the highest per-employee profit in the industry at this time, but were also well-known for missing intended release dates.

In both illustrated cases, breaking the social norm of working only within a discipline or profession came at the manageable cost of requiring additional time, while yielding beneficial value. Nonetheless, what happens when breaking a different kind of boundary? Let’s consider an alternative case. Types of motorized transportation are not only considered to be one of the biggest global polluters of our time, but their exhaust fumes are also the cause of many deaths each year. Therefore, there is a societal expectation that the manufacturers of these vehicles, reduce the emission of these gases through effective production practices. For many, the moral obligation of reducing harm to the planet as a whole drives this societal expectation.

The way the ‘diesel-gate’ scandal is currently portrayed suggests that at some point, the technological progress of car manufacturing was not as fast as engineers, managers, or maybe even the general public expected it to be. At some point, an additional device was added to vehicle engines that did not reduce the release of nitrogen oxides (the outputs most relevant to air pollution), but instead, intentionally deceived everyone into assuming that the exhausts were less harmful than they were. The vehicles

with assumed low emission values were then heavily marketed by the manufacturer and became a considerable success. To achieve this, the people who knew about the additional device deceived their colleagues, families, and society by breaking a set of protocols. This initial change introduced in the small-engine fleet of one manufacturer increased the pressure on engineers working on other engines in the same company and their competitors. Quickly, a number of copy-cats used the same 'creative' workarounds when they could not technologically solve the problem. While in this example the whole planet loses, these individuals who knowingly broke the protocols or willingly accepted others doing it, destroyed normative boundaries and benefited financially.

These instances of rule breaking and destroying normative boundaries might result in experiencing an aversive reaction, and ethics can help unpack this tension. More specifically, by turning from considering social norms to *moral norms*, which are the rules that help individuals figure out how to behave *appropriately*. These rules have "universal content" and adherence to them is often independent of what others do (Bicchieri, 2014). For example, most people would agree that killing someone is morally wrong because it violates the moral value of a duty to care for others. Nevertheless, whether (and which) moral values are universal (or cross-cultural) is not discussed at length here. There does appear to be variation, even in moral values that would arguably be considered universal at first glance. For example, consider the number of honor killings in many subcultures; these are a reminder (perhaps to Western societies specifically), that a moral diversity exists in the modern world. Also in Western societies, certain professions are trained in killing people to protect the social norms of the society by violating the moral norms of the individual.

In the diesel-gate scandal, the actions of engineers and managers in deceiving and harming others, in order to further their success, appears to violate the moral values of trustworthiness and respect. The focus on moral costs raises the stakes, and it is harder to gauge whether the pay-off between destruction and creation is justified. This is not to say that the evaluation of these and similar situations will necessarily be negative. In a broader context, unethical behaviors that result in intriguing, exciting, and innovative outcomes are often admired as clever forms of trickery. In fiction, a large audience certainly seemed to admire Danny Ocean and his collaborators when they broke into a multi-million dollar vault using an innovative set of plans in the film *Ocean's Eleven*. Rule-breakers are often praised and acknowledged for their innovative practices. In fact, across several experiments, research has found that creative forms of unethical behavior are judged less severely than less creative forms of unethical behavior (Wiltermuth et al., 2017). This distinction demonstrates how complex the interplay is between moral norms and actual morals; individuals might value moral universals like obedience, but they also possess an affinity for those individuals who dare to be different. This complexity adds to the struggles that organizations face in providing both clear boundaries and freedom, to motivate creativity but not unethical behavior.

Deception: Destructive or Creative Communication

The boundary between creative versus destructive is somewhat tangled, particularly when appraising unethical behaviors. Research examining the destructive side of creativity has often focused on dishonesty and deception specifically (e.g., Gino and Ariely, 2012). Of course, deception can take many forms and the boundary between deception and lying is often unclear. Here, the term "lie" is an act to intentionally mislead others when they expect honest communication. This focus on deceptive communication is not surprising, given that lying is probably one of the most common wrong acts. While some have argued that dishonesty involves breaking a social principle that the truth should be told, others have explored morally-focused accounts of deception stating that lying is bad and immoral and nobody likes a liar. Here is a more detailed example of the implications of deceptive communication. Moral values like honesty and trustworthiness, are complex because they require taking into account people's motivations for lying and the outcomes of their deceptive behavior. It seems reasonable to assume that honesty is a moral good and that dishonesty is a fundamental moral wrong, but the relationship between honesty and moral action is not straightforward. Note the distinction between what might be considered *bad* (as the opposite of good) versus what might be considered *wrong*. Some argue that only actions can be *wrong*: while someone falling off a cliff would be bad, pushing a person off a cliff would be wrong.

However, in varying numbers of instances, it might be considered acceptable to lie. For instance, people might *tell a white lie* to a friend who bought them a present that he or she didn't like – "Yes, I just love it!" – in order to protect their feelings. In these instances, lies are motivated by compassion and individuals who tell these so-called "prosocial lies" are judged to be more trustworthy. In fact, in some cases, it seems a moral obligation to deceive. If you were approached by an assassin and asked where their *target* was, would you reveal their victim's location? In these cases, it seems that honesty is not a moral good in all instances and neither is dishonesty always morally wrong.

Aside from situations in which lying might be morally justified such as in the case of protecting someone's feelings or sparing someone's life, what about using deception to produce creative outcomes? For example, a competitive salesperson, who is willing to bend the rules and provide additional incentives and leniency to their customers, is likely to benefit financially and is therefore motivated to continue acting deceptively. While hopefully this kind of self-interested deception would be punished and discouraged by an individual's moral compass, this is not always the case. In fact, individuals can manage the balance between maintaining a positive self-image and a desire to maximize self-interest through "self-serving rationalizations" which enable them to justify small amounts of deception or dishonesty. As such, instances in which individuals can justify dishonest behavior will likely promote some form of dishonesty.

Research has shown that simply thinking that you are creative, can lead to a sense of entitlement, given that creativity is perceived as a valuable attribute. This sense of entitlement can then enable individuals to justify questionable behaviors using self-serving rationalizations. So in the case of the salesperson above, the extra income from their customers and praise for high customer

retention they receive as a result of their creativity, might lead the salesperson to justify further deception and dishonesty because they now "... feel licensed to cheat" (Gino and Ariely, 2012, p. 455).

Personality Traits, Creativity, and Destruction

Personality traits play a role in shaping the actions of the "destructive actor". Research indicates that individuals with creative personalities are more likely to engage in unethical behavior (such as cheating) and as we explored previously, this appears to stem from an ability to justify dishonest behaviors. Consequently, it seems as if dispositional creativity directly relates to destructive acts. However, are these traits also associated with creativity? "Destructive personality traits" is a relatively broad term that might include traits that promote self-destructive tendencies (which are discussed later in this section) but also traits that motivate destructive acts against others. Focusing on the latter, the next section will address socially-averse personality traits that comprise the Dark Triad (narcissism, psychopathy, and Machiavellianism) and their relationship to both destruction and creativity.

The Dark Triad and Creativity

Narcissists have an exaggerated sense of self-importance and a strong sense of entitlement. Like the other Dark Triad traits, a narcissist's destructive tendencies might appear in the form of the manipulation of others and callousness toward them. In the previous section, the point was made that merely thinking of oneself as creative can lead to a sense of entitlement. This increased sense of entitlement can result in more creative outputs. Given that narcissists have an inflated sense of entitlement, perhaps it is not surprising that individuals high on narcissism believe themselves to be more creative. This observation seems to support the theory that narcissists, being self-aggrandizers, exaggerate their accomplishments and overestimate their creative potential relative to others.

While research suggests that narcissists are no more proficient at coming up with creative ideas when their performance is objectively measured (Goncalo et al., 2010), others will often rate them as more creative because they display the prototypical traits of a creative individual. More specifically, individuals high on narcissism have high levels of self-confidence which enable them to sell their ideas more enthusiastically. This art of persuasion could explain why narcissism is a predictor of leadership emergence (Grijalva et al., 2015). How narcissism might contribute to creative efforts becomes even more complicated, when we consider the finding that narcissistic group members boost overall group creativity, even if they do not (objectively) perform more creatively in isolation. Again, the interplay between destruction and creation in these individuals appears to be tangled. Importantly though, despite the apparent destructive nature of narcissistic traits, it seems that collaborating with these individuals can, in fact, produce "... a valuable source of creative tension" (Goncalo et al., 2010, p. 1493).

Like narcissism, high psychopathy often relates to destructive tendencies such as lack of empathy and callousness toward others. As a triarchic construct, psychopathy couples with disinhibition, boldness, and meanness. As well as independently exploring the link between narcissism and creativity, research also investigated the relationship between psychopathy and creativity. For example, Eysenck (1995) explored the relationship between psychopathology and creative genius noting that "... actual psychosis is destructive" but that "... high psychopathology short of diagnosed psychosis is apparently beneficial" (p. 117).

In fact, the prosocial psychopath model of creativity suggests that a few highly creative personalities share some neurophysiological features in common with individuals with psychopathic traits and that traits related to psychopathy such as boldness, correlate with creative achievement. This link between psychopathy and creativity is thought to derive from emotional disinhibition. Again, the picture of the interplay between psychopathy and "prosocial" or creative acts, is far from simple. In fact, in broader investigations of the relationship between the Dark Triad (narcissism, psychopathy, and Machiavellianism) and creativity, research has found that both psychopathy and Machiavellianism are positively associated with harm-based creativity. For example, in a study utilizing divergent thinking tasks, answers for using a brick as a weapon received a higher score than constructive uses. Results suggested that individuals on the spectrum further toward these "darker shades" of the Triad also show forms of creative expression that are biased toward destruction.

The role of individual differences here, does not stop at creative and destructive dispositional traits. The process by which personalities are shaped across lifetimes might be understood as a sequence of creation and destruction. Self-creation unfolds from birth as we meet a number of developmental milestones and are motivated to reach new limits and achieve new goals. At the same time, individuals also engage in a number of self-destructive behaviors and processes. Like creativity, self-destruction might be discussed at the social, psychological, and physiological levels. For example, withdrawal from a peer group or the incapability to participate in social life, leads to the destruction of the self within its surrounding society. Different phenomena such as decreasing cognitive and perceptual abilities drive the individual's psychological destruction. Often these factors are intertwined with physiological decay and are considered to be finalized by the biological death of a person.

Malevolent Creativity and Benevolent Destruction

This entry explored the relationship between creativity and destruction at a conceptual level, demonstrating a binary dichotomy based on the definition but also explored, was the complex interplay between processes and people that both create and destroy. Normative considerations regarding the relationship between creativity and destruction focused on whether the benefits of

destroying something to produce a creative outcome, outweigh the costs. Taken together, it seems that evaluations of single creative and destructive acts or the dispositions of creative and destructors actors rely on the understanding that both creativity and destruction can be assigned either a positive or negative valence. For example, creativity will not always be benevolent; the “dark side” of creativity suggests that individuals will sometimes act dishonestly for self-interested motives and bold or callous individuals will often engage in harm-based creativity. On the opposite end of this scale, destruction will not always be malevolent; individuals who strive to destroy harmful social norms do so because those norms pose a threat to their group and innovative individuals will often break particular social rules in order to innovate and inspire. While most societies theoretically desire to both condemn destructive acts and reward creative acts, to punish rule-breakers and praise innovators, and to ostracize antisocial individuals and welcome individuals that inspire, a binary dichotomy of creation versus destruction does not apply to all actions. In some cases, the actor is both creative and destructive. Perhaps destruction requires the same detailed discussion as creativity, to further distinguish it in its personal, temporal, linguistic, and normative dimensions.

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Creativity and Perspective

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Introduction

Changes of perspective are related to creativity in many different domains. Many artistic styles develop, for instance, when an artist or group of artists recognizes the need to change the way the world is viewed. The new style, in this sense, presents an alternative perspective.

Dramatic shifts also characterize the sciences. In Thomas Kuhn's well-known model, *normal science* involves the accumulation of factual information, which is collected with theories and methods that reflect a similar perspective of the world. At some point, however, existing theories are found to be inadequate to explain certain observation. A dramatically new perspective results from a paradigm shift. These are dramatic in the sense that they do not merely extend the thinking that came before but instead introduce a completely new way to view the world. Examples include the scientific revolutions of Copernicus, Darwin, and Einstein.

Albert Einstein seemed to have developed some of his most significant insights using thought experiments. He imagined himself riding a beam of light, for example, or on a train moving in the opposite direction to another train. These thought experiments gave Einstein a unique and useful perspective on the relativity of our physical world.

Picasso has often been quoted as saying that he learned to paint only after he remembered how to think like a child. Picasso was well aware of the assumptions and routines adults too often develop. More often, an adult's perspective will differ from that of a child.

One of the most dramatic changes in literature occurred when Dorothy Richardson and James Joyce developed stream-of-consciousness styles. They shifted the perspective within the novel, away from the observer or third person and to the individual or protagonist.

As Runco described this in an article on problem finding,

Richardson, author of *Pilgrimage*, seems to have been the first to use stream-of-consciousness in literature. Her insight was that a new perspective in literature was needed. This led her to reorganize her thinking and writing about the protagonist of *Pilgrimage*, Miriam Henderson. Rather than describing the character and her actions, Richardson began to *take the character's point of view* and describe the 'inner psychic existence and functioning' for the reader.

Runco (1994: 374)

Doris Wallace is quoted on this issue of 'inner psychic existence and functioning.' Wallace concluded that the organization and reorganization in Richardson's writing reflects a type of problem finding, for no one before Richardson saw the need for a new perspective. Wallace also described the history of insights, arguing that they are constructed over a long period of time. This is apparent in the work of Darwin and Richardson and other creators who had insights only after they considered a problem for a long period of time (Wallace, 1991).

Perspective Shift is Fundamental to Creative Processes

As this discussion of paradigm shifts may suggest, shifts in perspective, like those of Copernicus, Einstein, and Darwin, can lead to dramatic changes in world views. In this sense the shift is the mechanism which leads to the insight. Shifts of perspective may underlie other processes related to creative work. Recall here that shifts in perspective may be literal or metaphorical. Consider

the tactic (often used in the research and in programs designed to enhance creative potential) to 'stand the problem on its head.' The idea here is to turn the issue upside down – to obtain a different view. Programs sometimes suggest magnifying or minifying a problem. In the former the problem or its representation is enlarged. In the latter the problem or its representation is reduced. Again, this requires a shift of perspective. Another recommendation for finding creative ideas is to stand back and change one's 'level of analysis.' Related to this is the suggestion to alter the medium being used to represent the problem. Use words instead of numbers or pictures instead of words. There may be several benefits to these changes, but certainly one of them is that a change of perspective is involved.

There are various explanations of the *incubation* that is often tied to creative insight. There may be a preconscious relaxation of constraints, allowing alternatives to be found. Incubation may be effective precisely because it allows one individual to find a new perspective and to break away from an existing viewpoint. Most of us have probably had the experience of taking time away from some difficult problem, only to return and solve the problem easily because we saw something more obvious after the break (the incubation) that we were overlooking or taking for granted before.

Perspective Shift and Cognitive Flexibility

The relationship between perspective shift and creativity is also shown in the importance of cognitive flexibility in generating creative ideas. Cognitive flexibility refers to the mental ability to shift from one idea or perspective to another in order to overcome the fixed association and generate new associates. It is mainly manifested in the use of broad cognitive categories or perspectives and frequent switches among cognitive categories. Empirical studies have supported that using perspective shifting or perspective taking increases the generation of creative ideas. This can be explained by a dual process theory of creative cognition, which suggests that both associative and executive processes are involved to produce creative ideas. Further, the ability to generate creative ideas, or the ideas that are original and appropriate, is a function of cognitive flexibility and cognitive persistence. Specifically, cognitive flexibility may lead to high level of originality whereas cognitive persistence may lead to high level of appropriateness.

Developmental Trends

Individuals may intentionally change their perspective in order to increase the likelihood of a creative insight. There may, however, be developmental trends in the capacity for shifting perspective. These would suggest that changes of perspective are more difficult for younger individuals and perhaps should not be encouraged early on. Most obvious here is the tendency for young children to be *egocentric* in the sense that they cannot take someone else's perspective. Only in adolescence do individuals recognize that others hold different perspectives from one's own. To the degree that these general cognitive tendencies relate directly to creative problem solving, we would expect age differences in the capacity for using changes of perspective in a tactical manner to increase one's originality and creativity. This certainly would be consistent with theories of metacognition, with younger children not recognizing that tactics and intentional efforts are necessary for problem solving.

Mood Swings and Perspective

A large amount of attention has been directed to the affective disorders of creative persons. Typically these are bipolar disorders, which are characterized by mood swings. Such mood swings may be functionally tied to creative work; and here again it is possible to speculate that there are relevant changes of perspective. Put briefly, the mood swing may provide the individual with more than one perspective of his or her own work.

This hypothesis is supported by anecdotal reports by creative persons that they are (a) highly productive but not critical when they are experiencing the mania of a mood swing, and later (b) highly critical – an effective editor so to speak – when they experience the depression which characterizes the opposite extreme and other polarity of the mood swings.

Mood states also influence perspectives through the effect of cognitive flexibility. In general, based on the dual process model, positive mood states influence creativity through the stimulation of cognitive flexibility and negative mood states influence creativity through the stimulation of cognitive persistence. However, the relationship is far more complex than it appears. For instance, the effects of positive mood states on creativity can only be found with the mood states such as happiness and elation, but not for others such as feeling calm and relaxed.

Cognitive and Extracognitive Influences on Shifts of Perspectives

Shifts of perspective require particular cognitive capacities. Some shifts may require visualization or other sensory capacities, as would be the case when the individual literally imagines what another perspective would look like. Higher order abilities are also required. The shift may, for example, take the individual to a hypothetical perspective; and this requires formal operational thinking. The shift may require that the individual imagine him- or herself in someone else's shoes. That is a special kind of

hypothetical reasoning that reflects *sociocentric thinking*. This too is cognitively demanding. Young children, for example, are egocentric rather than sociocentric and unable to shift to someone else's point of view. This is not a matter of choice but is instead a reflection of the maturity (or lack thereof) of the nervous and cognitive systems.

Extracognitive capacities are also required for shifts. Open-mindedness is required, for example, because the individual must acknowledge that there are other possibilities. A courageous attitude may be necessary so the individual is willing to try something new, and perhaps take a risk with it. Ego-strength will certainly be necessary. This provides the confidence to actually use one's personal creative license. Ego-strength may be especially important because creative ideas and insights are often unconventional; and if they are found by shifting perspective, that shift may be away from conventions, norms, traditions, and expectations. It is analogous to what has been called *artistic license* but it may not involve art; hence the term *creative license*.

Beauty is in the Eye of the Beholder: Perspective Differences Influence Judgments of Creativity

To the degree that creativity is a social phenomenon, it is dependent on interpersonal judgments – and these will very likely vary depending on the perspectives held by the different persons involved. As a matter of fact there is a principle in social psychology that predicts that two people will tend to form different hypotheses to explain their actions. The person doing the action will tend to explain it in terms of the immediate environment and context. An observer of the same action will focus his or her explanation on the person involved. This follows from the divergent perspectives of the two individuals. The person doing the action will tend to look away from him- or herself. Their physical perspective will be oriented outward. The observer, on the other hand, will probably see the person doing the action as salient and spend most of the time viewing that actor. This may apply to creative work, and a creator may explain his or her work contextually while an audience will emphasize the creator. The most important point is that discrepant perspectives lead to different opinions.

No wonder that (a) different judges often disagree about the qualities of creative work, or even about the level of creativity in the work, and (b) opinions of creators often differ from those of audiences and judges.

This line of reasoning about interpersonal judgments implies that implicit theories are relevant. Implicit theories are held by parents, teachers, or any group of nonresearchers. Scientists and researchers hold explicit theories, which are explicit in that they are articulated, shared, discussed, presented, published, tested, and so on. But nonresearchers also have stable views of creativity. They are not shared nor articulated, so they are implicit instead of explicit. They are quite important since they can lead to the expectations that in turn have a notable impact on development and behavior.

Simply put, implicit theories probably assume a particular perspective. Consider the example of a teacher whose perspective on creativity is that it is domain specific. He or she may not look for an artistically creative student to do much in science or some other domain. Conversely, if a teacher's perspective on creativity reflects the implicit theory that creative talent is general rather than domain specific, he or she might expect the artistically creative child to also perform in an original fashion in science and other domains. Much the same applies to the explicit theories of creativity held by researchers and individuals actually studying creativity. Their perspectives will lead them to expect certain things and ignore others (i.e., those traits that are thought to be irrelevant to creativity). The point is that there is probably a strong relationship between implicit theories and particular perspectives on creativity.

The effect of perspective taking on the judgment of creativity is also confounded by other factors. For instance, individuals who are more prosocially motivated tend to adopt others' perspectives. This in turn helps these individuals to integrate different perspectives and create more useful products as well as understand what product is useful for people working with them. Diversity in a team also increases creativity because a more diverse environment enhances team members' willingness to consider others' perspectives. In addition, the effect of perspective taking on the judgment of creativity also depends on how much information is provided for the judges about judged products and the individuals who make these products. For instance, a group of undergraduate student raters provide significantly higher ratings for the products when asked to take the perspectives of the individuals who make the products than when they are only told the age of the individuals who make the products.

Conclusions

Shifts of perspective are fundamental to several facets of the creative process. Some tactics may work effectively because they force the individual to shift perspective. Even though perspective is not mentioned in many programs which present recommendations to individuals who hope to maximize their creativity, a change of perspective may be implied in some of the recommendations that are suggested, and its occurrence (a shift of perspective) may explain the benefits. A change of perspective may have several benefits. A shift of perspective may, for example, break the individual's routine and allow him or her to find an approach that is uncommon or novel. Novelty is of course a correlate of originality; and originality is in turn vital for creative insights. Shifts of perspective may thus have their effect because they lead directly to novelty. The breaking of routine may be sufficient for the finding of creative ideas and solutions. Much research has demonstrated that fixity precludes originality, and that avoiding fixity or breaking one's mental set can lead to original problem solving. The benefits of changes in perspective are numerous.

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Creativity and the Future

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Glossary

Futures studies The study of the future, also known as futurology or foresight.

Improvisation The ability to create in the moment.

Regenerative culture A worldview that see humans as connected to and collaborating with nature and other human beings.

Social innovation A discipline that approaches social problems from the perspective of innovation.

Introduction

Human creativity shapes the future. Creativity is how the future comes into being, and human beings are only beginning to see how they are creating the future. The creativity of the modern age led to tremendous progress in science and technology, leading to rapid social change. The very forces that led to progress are now viewed as contributing to the great problems currently facing humanity, whether environmental, economic, or social. Creativity and innovation are drivers of the economy, and there is an increasing awareness of the importance of creativity. Creativity is central to futures visioning processes and to scenario planning. But there is also debate and questioning about *how* creativity is being used, what kind of futures are being created, to what ends, and by whom.

Overview

Thinking about the future poses any number of challenges. Perhaps the biggest challenge is how one can even begin to think and know anything about something that hasn't happened yet. Nevertheless, history tells us human beings have always wanted to know about the future and what it holds. Prediction has been a continuous thread through humanity's interest in the future, often for reasons of survival, whether to predict the effect of weather on agriculture or threats to life and limb from marauding visitors. Attempts at predicting the future have included the mystical (e.g. clairvoyant visionary seers), the cosmic (astrology), the relatively pedestrian (e.g. extrapolating from present trends), and more recently high-tech forecasting (e.g. Big Data).

Along with attempting to predict the future, human beings have *created* the future. They have envisioned futures utopian and dystopian, created new technologies that transform the way they live and work, and in their everyday choices and decisions willy-nilly created the direction of their lives. Individuals play a creative role in their future through their imagination, actions, and decisions.

Looking back on their lives, most people find that some of the most critical events and choices were unpredictable and indeed serendipitous. The future can be full of surprises which can range from finding the love of one's life to winning the lottery to earthquakes, hurricanes, and plagues of locusts, as well as a lot of less dramatic yet unexpected events and experiences. History has notable examples of the unexpected from the ripple effect of an assassination in Sarajevo in 1914 to the fall of the Berlin Wall to the election of Donald Trump. The world seems to be getting more unpredictable as it becomes more interconnected and interdependent through instantaneous communication and the networked society. People do not create the future in a vacuum, or exclusively in the unsullied province of the imagination. People create the future with the materials and realities at hand. They can respond to unforeseen creatively, or by trying to keep doing what they've always done.

Today there is increasing agreement among futurists and social critics that the world is currently in a period of significant transition, an in-between state that is marked by the frequent use of the prefix “post-” to describe it, such as post-industrial and post-modern. The British futurist Ziauddin Sardar stated that as a result of this transition society is now in postnormal times. In postnormal times, nothing seems “normal” anymore and chaos, complexity, and contradictions are its defining characteristics (Sardar, 2010). Society has left one age behind but has by no means settled into a new order, if indeed there will be one. Modernity has exhausted itself, in this view. Science, technology, industry, appeared to provide solutions for the challenges of existence and were seen as sources of a bright future. They were the drivers of progress. But the seemingly limitless faith in humanity’s capacity for betterment has increasingly turned to skepticism and even distrust, with an awareness that science and technology, and visions of progress cannot be insulated from human greed, errors, and illusions. Futurists and social commentators agree that as a result of this transition, this in-between state, the future is increasingly uncertain. Any number of terms have been used to capture the uncertainty. The Polish sociologist Zygmunt Bauman refers to current times as Liquid, fluid and ever-changing, leaving behind the Solid world of Modernity. The US Army War College uses the acronym VUCA, which stands for Volatile, Uncertain, Complex and Ambiguous to describe the current global situation.

Science and technology have been the biggest drivers of social change, particularly in the last 200 years. They are central to how humanity has created its futures. But the creativity of the arts has also played a role in society’s views of the future, science fiction being but one notable example. The impact of music, the visual arts, and literature has been significant. *Pamela, or Virtue Rewarded* by Samuel Richardson was published in 1740 to huge success. It was the first novel in the English language, and arguably sparked an explosion of the imagination and the age of Romanticism. Ideas, beliefs, and philosophies also shape the future. Political and economic ideologies like communism, capitalism, and socialism, human creations one and all, have transformed societies across the globe, for better or worse. Religious movements with their rituals, beliefs, and codes of conduct have shaped lives, in some cases with very definitive ideas about our futures in the afterlife. Human beings create theoretical frameworks to interpret the world, and these theoretical frameworks, in turn, shape human beings and their worlds.

Creativity and innovation have become central to the new economy and play an essential role in new disciplines like Social Innovation and Design. Sardar stated that what is most needed at this time are creativity and imagination, because as the old world is dying a new world can be envisioned and enacted. But it seems that creativity itself is changing. The creativity of Modernity, exemplified by the image of the lone genius decontextualized from the larger environment, may not be the creativity of the 21st century. A new contextual and relational understanding of creativity is emerging and increasingly influencing the way some groups are envisioning and creating alternative futures.

Brief History of the Future

What will the future bring? This question continues to be asked by human beings all over the world. History shows there have been many different ways of addressing it. Two ancient divination systems, the Chinese I-Ching and astrology, are still popular today. Both can be dated to approximately 3500 years ago. While they are dismissed as pseudoscience by the scientifically inclined, their continuing popularity indicates that our interest in divining the future has not abated. In recent years, US President Ronald Reagan was known to consult an astrologer who advised on such things as propitious times to meet with foreign leaders and sign agreements. In the early 21st century, clinical psychologists are increasingly finding clients who draw on the language of astrology.

The Industrial Revolution and the modern era led to a great acceleration in the rate of social change in Europe. Science and technology transformed manufacturing, agriculture, medicine, and transportation. The concept of progress emerged in Europe around 1680 and was fully developed in the 19th century. Before that time there was no sense of continuous improvement—if anything, the notion of a fall from a Golden Age was not unusual. The idea of progress stressed the value of reason and its application to science and research, the importance of technological and economic growth, and the achievements and superiority of European civilization.

The notion of progress was deterministic, holding that there is a linear inevitability about human betterment. This in contrast with earlier views that saw a Golden Age receding ever further in humanity’s past, or viewed time as circular rather than linear, with patterns of growth and decline. This linear view of the future inevitably led to predictions about what the future would hold, primarily focused on how new technology would change everyday lives. Advertisements were breathless with the promise of what science and technology would bring to every aspect of people’s lives. Popular images of the future dating from 1900 or the 1950s and 1960s show remarkable new technology, particularly of the flying kind, but virtually no changes in gender roles, for instance. In highly popular 60s television shows such as *Lost in Space* or *The Jetsons*, mom is still in the kitchen, albeit aided by new domestic marvels. It is perhaps not surprising that reviewing the vast and lively imaginary of predictions and science fiction scenarios of that time people of color barely appeared, and nature is often hard to find. Visions of the future say as much about current society as they do about the future. But beneath the optimism and faith in progress, Mary Shelley’s (1797–1851) *Frankenstein* already explored the dark underbelly of human ambition coupled with the powers of science.

H.G. Wells (1866–1946), a polymath and science fiction writer, is often seen as a founder of future studies. Wells wrote a book describing what life would be like in the year 2000, as well as such classics as *The Time Machine*, *The War of the Worlds*, and *The Island of Dr. Moreau*. Wells felt strongly that the disciplined study of the future was necessary. Along with the earlier work by Jules Verne (1828–1905), Wells established a strong connection between imaginative fiction, the study of the future, and the images of the future in the popular imagination.

In the middle of the 20th century, systematic studies of the future emerged in the shadow of the cold war, population growth, and environmental dangers. Different approaches emerged over the years, with American futurists (predictably) focusing more on short-term, applied, practical, quantitative approaches and Europeans (equally predictably) studying the long-term and the broader philosophical issues of future studies. The future was now studied in think tanks such as the Rand Corporation, the Club of Rome, and the Stanford Research Institute. American futurist Herman Kahn studied the future of thermonuclear war, and the Club of Rome published the influential *Limits to Growth* report about population growth, economic growth, and finite resources.

In the 1970s, the approach to the future took a novel turn with the emergence of scenario thinking. In the 1960's, Shell Oil found the traditional quantitative, rational approaches to long-term planning wanting. The alternative they embraced was scenario planning, which borrowed from the earlier Delphi method that used predictions from structured groups of experts. As a result of having explored several possible futures scenarios, Shell was much more prepared than other oil companies when the oil crisis and economic embargoes of the 1970s began. Rather than attempt to predict a single future based on extrapolations from the past and present, scenario thinking involves a process whereby a group of carefully chosen participants envision a number of possible scenarios for a specific company, industry, or nation. Particularly in its most advanced form, developed by the highly successful Global Business Network (GBN), the invited participants often included representatives from the arts and academia to provide a rich range of perspectives, and the process was described as both an art and a science. Scenario planning has been described by a leading practitioner as a form of social creativity (Ogilvy, 2002).

More recently along with a renewed interest in forecasting because of the enormous power of big data, there has been a shift toward embracing the saying that one cannot predict the future, but one can invent it. The pervasiveness of creativity in its many forms and expressions in today's culture also raises the question of *what* is being created, and whether what is being created is determined solely or primarily by the market economy. What is being created says a lot about the creators and what their values are, as well as about what the future will be like. As creativity reinvents lives and societies it is inescapably intertwined with larger social and ethical questions.

Utopias and Dystopias

Creativity and imagination have always played a role in the future, whether it is envisioning desirable or disastrous futures, predicting changes, or creating scenarios of possible and probable futures. Nowhere has the role of creativity and imagination been more explicit than in the creation of utopias and dystopias, ideal and nightmarish societies respectively. The first utopia was described in Plato's *Republic*, a decidedly anti-democratic vision of social order run by Philosopher-Kings. The term Utopia was first used by Thomas More as the title for his novel about an island in the South Atlantic off the coast of South America. It is telling that, as with many utopias, the book has been interpreted as a straightforward description of an ideal society, and also as a work of satire and social criticism. Even the title was ambiguous, a play on words, with the Greek *ou-topos* meaning nowhere, and *eu-topos* meaning a good place. It is characteristic of utopias that they often have deep-seated ambiguities, being at the same time a critique of the present, a vision of an alternative future, and an imaginative literary construction.

In the 21st century utopias have given way to dystopias. Already in the 20th century, such classics as Orwell's *1984* and *Animal Farm* and Aldous Huxley's *Brave New World* and *Island* warned of the dangers of mass manipulation, state control, and the use of mind-altering drugs. These themes were picked up by one of the century's most eccentric and wildly productive science fiction writers, Philip K. Dick, whose feverish, visionary novels combined a potent strain of paranoia with mysticism, mind-altering substances and dialog that often seemed straight out of a noir novel. His work has been turned into movies, producing some very successful and hard-hitting science fiction for screens small and large. It includes such dystopian classics such as *Blade Runner*, *Total Recall*, *Minority Report*, *The Adjustment Bureau*, and *The Man in the High Castle*. Dystopian fiction is now a major category both in literature and cinema. It captures a rather bleak mood, particularly among younger people, reflecting high anxiety about the environment, the economy and more generally the state of the world.

The French thinker Edgar Morin has argued that there is currently a "crisis of the future" (Morin and Kern, 1999). This crisis manifests, among other things, in the lack of desirable visions of the future and skepticism about whether there is any possibility of "better" futures. This age can be described as post-progress, because of the lack of compelling views of the future. The notion of progress, let alone of a determined, inevitable progress (e.g., every generation will earn more than their parents, technological advances always lead to improvement in quality of life), has faded, at best replaced by the term "sustainability." The Dutch futurist Fred Polak warned of the dangers of a lack of positive images of the future (Polak, 1973):

The rise and fall of images of the future precedes or accompanies the rise and fall of cultures. As long as a society's image is positive and flourishing, the flower of culture is in full bloom. Once the image begins to decay and lose its vitality, however, the culture does not long survive. (p.19)

With the lack of faith in politicians, institutions, and even in science, which is often viewed as beholden to corporate interests, there is a sense that it is increasingly difficult to talk about the future and envision "better" futures. The very notion of better futures is met with considerable skepticism, particularly by younger generations. Terms that emerged with modernity, like progress, carry too much of its conceptual baggage, suggesting a linear, deterministic movement. Already in the 20th century the horror of two

world wars broke the spell and led to a major questioning of the values and assumption of Western culture. In the 21st century a further change has occurred as young people in Europe and the United States realize that it is unlikely most of them will be economically better off than their parents and there is increasing anxiety about environmental catastrophes. In emerging powerhouse economies like China, where the last 40 years have seen perhaps the greatest and most rapid economic transformation in history, there is already an emerging questioning among younger generations of the values and benefits of consumerism and materialism.

An entirely different vocabulary and set of concepts is needed to address the complexity of the current global situation and the envisioning of alternatives. In an age when interest in creativity and imagination has reached an unprecedented degree, questions of what to create and what kind of futures humans want to create and who they want to become loom large.

The Creativity of the Future and the Future of Creativity

In postnormal times, the role of creativity and imagination is central to envisioning images of desirable futures. Without them, as Polak suggested, societies enter a steep decline. But will the same creativity of modernity be humanity's savior? This raises the interesting question of whether or not the unsustainability of modernity was a function of the way creativity was conceptualized and embodied in modernity. As modernity (and now arguably even post-modernity) are left behind, there is a recognition that there was a creativity typical of modernity, and that creativity itself is changing as culture moves into a yet unknown age (Montuori, 2011).

With the industrial revolution human ingenuity was applied to control nature for purposes of production. The industrial creativity of modernity was decontextualized with, for instance, little or no concern for the waste products coming from factories and industrial plants. Nature—society's "environment"—formed a generic context and was perceived to be so enormous and abundant that waste products could be dumped in rivers, in the air, and in oceans without ill effects. The enormous scientific, technological, and industrial creativity that fueled visions of progress and human betterment is now also viewed as a source of the current environmental crisis. This decontextualized view of creativity has ultimately proven to be unsustainable.

There are several indications that the discourse and practices of creativity are changing. The Millennial generation is made up of digital natives who have grown up in a networked, interconnected society, in an age in which the traditional image of the genius has taken some knocks. Creativity for the Millennial generation is not so much about a lone genius working in the arts or sciences, but rather about everyday, everyone, everywhere, relational creativity. When asked about creativity they are less likely to refer to remarkable individuals or "eminent creatives" and more likely to refer to the way friends and relatives did something creative together. This is paralleled by shifts in popular culture, where for instance on television such traditional figures as the lone cowboy or lone private investigator and even individual superheroes are far less prominent, while groups or tribes of heroes are increasingly popular (e.g. Marvel Avengers). In industry, collaborative creativity has taken on great importance. Innovation, a process which goes beyond an individual having a remarkable insight but extends to turning the idea into a product and getting a product to market, inevitably involves multiple participants.

There are also new approaches to creativity found in biomimicry and the concept of regenerative culture. Both are explicitly more contextual, expanding the creative process to include explicitly enriching rather than depleting or polluting the natural and social environment. Biomimicry uses nature as a source of inspiration for creativity. Regenerative culture sees humans as connected to and collaborating with nature and other human beings rather than separate from Nature. It is a systemic creativity rather than the individualistic creativity that emerged with Modernity, which viewed the individual as separate from and generally in opposition to the social and natural environment, exemplified by the image of the lone genius. Creativity in the regenerative view is part of a larger ecosystem. The larger ecosystem, meaning the total environment from which creativity emerges, is not to be exploited but regenerated. This is a very different, participatory view of creativity that in some ways harkens back to Asian views of creativity as an ongoing process in an interconnected world (Tu, 2007). This form of creativity is more contextual and collaborative, and is represented in emerging current practices designed toward creating better futures.

Uncertainty, Reinvention, and Education in a Time of Transition

The future is uncertain, and human beings generally do not respond positively to uncertainty. Neuroscientists have argued that humans crave certainty—or rather, the *feeling* of knowing and certainty. The current tendency toward polarization in public discourse in many countries across the globe is, among other things, a result of the confusion created by the current *interregnum*, this ongoing state of post-, with modernity ending but no alternative future in sight. This transition creates anxiety because it affects some key dimensions of human existence. While many names and interpretations have been given to the current transformative moment, one way to frame it is as a form of global identity crisis. An identity crisis is associated with a psychosocial moratorium, a time when new identities are explored and tried on, but also a time during which there is a goal moratorium, either an absence of goals or conflicting goals that lead to a degree of paralysis. The concept was originally applied to individuals but has also been used to explain social phenomena.

Reinvention is a trend emerging from a confluence of factors, including the self-help tradition that has long been part of American popular culture, "post-materialist" culture, and the changing and increasingly unpredictable social environment of postnormal

culture (Elliott, 2013). People are reinventing their bodies (e.g., plastic surgery and yoga), reinventing themselves (e.g., therapy, coaching, meditation), reinventing their careers, reinventing their communities both physical and virtual, and organizations are reinventing themselves to become more creative and innovative, although not necessarily less exploitative. Creativity is mobilized to recreate just about every aspect of peoples' lives.

Another parallel trend is disruption, a term used to describe the reinvention of certain industries. It has its roots in economist Joseph Schumpeter's notion of creative destruction. This is exemplified in the way such companies as Uber and Airbnb have "disrupted" the transportation and hospitality industries, challenging the traditional domination of taxis and hotels. They have disrupted the traditional ways many people get around cities and where they stay when they travel, all made possible by digital technology.

There are tensions as attempts at reinvention multiply, but also a backlash that seeks to return to a previous time, generally viewed as simpler and better. As an example, the tensions pertain to the way people in the United States reinvent:

- their bodies (with plastic surgery, yoga, living longer but also the crisis of Alzheimer's and the graying of the population, transgender and transphobia),
- their gender identities (changing gender roles, the crisis of masculinity, the myth of superwoman, LGBTQI, #metoo),
- their work identity (end of the industrial age and the loss of jobs traditionally performed by men, women and the knowledge economy, the challenges of the digital economy, the gig economy),
- their potential as human beings (the human potential movement, positive psychology, the New Age, Oprah, extreme sports, "be all that you can be," "hacking the brain," microdosing)
- their national identity (cultural anxiety, history of systematic racism, individualism, demographics and the "browning" of America, the US role in the world, new immigrants, the clash over history textbooks, diversity and pluralism),
- their existence as citizens on one planet (globalization or planetization, the threat of the new world order, the debates about cosmopolitanism, diversity, pluralism, immigration),
- their relationship to nature (the environmental crisis, organic foods, GMOs, ecopsychology, vaccines, wilderness),
- knowledge (the knowledge explosion, search engines, information overload and the need for cognitive complexity, discernment and integration, "fake news")
- their religious or spiritual identities (the sense of a quest for meaning in life beyond simply material survival (post-materialism, fundamentalism, cults, "spiritual but not religious").

This example uses the US to illustrate the notion of an identity crisis that spans from the individual to the global, and attempts at reinvention, but similar identity crises are happening in one form or other all over Europe, in China and India, both of which have experienced a tremendous transformation in the last 30 years, as well as other emerging nations like Brazil (which is the global capital of plastic surgery, or instance). One of the key factors is ever-increasing diversity, and the lack of integrative factors.

The confusion and uncertainty brought about by all these changes can lead to a form of cognitive overwhelm as well as attempts to make connections between often disparate and even unlikely data points. This also explains the enormous surge in popularity of sometimes bizarre conspiracy stories. There is a desperate effort to make sense of the postnormal complexity and uncertainty and assuage anxiety. This anxiety can lead to seeing the world in terms of either/or, with some people embracing the new directions, while others reject them and long to return to the old order.

Despite the general assumption in the scholarly literature that human beings favor certainty and reject uncertainty, creative individuals appear to have a different attitude and can see in uncertainty and complexity an opportunity to create. Unfortunately, current educational practices the majority of schools across the globe, with their focus on standardized testing, do not foster creativity or prepare students for this complex and uncertain world. In the early 1960s, psychologist Jerome Bruner argued that the main task of education was to prepare students for the unforeseeable future. Runco has likewise argued that we must prepare for an unforeseeable future, and that creativity plays a central role in dealing with uncertainty and the unforeseen (Runco, 2016). Standardized testing prepares students to deal with existing situations in pre-existing ways and respond to questions for which the answer is already known. Critics of current educational institutions see them as mired in the industrial era and still overwhelmingly authoritarian. Despite paying lip-service to the value of creativity, educational institutions have not been able to integrate creativity in a systematic way. Even at the doctoral level, the absence of creativity is evident. The main reason why over 50% of students in the United States do not complete their doctoral studies is that they are unable to become independent scholars and make an original contribution to their field (Lovitts, 2008). Creativity is key to becoming an independent scholar is, but while plagiarism is strongly discouraged, creativity is hardly ever explicitly addressed as being central to doctoral research.

Creativity is essential to the kind of mastery expected in doctoral research particularly because a Ph.D. dissertation is supposed to be an *original* contribution to one's field. Research on the phenomenology of expertise suggest that individuals who have reached the highest level of mastery—like independent scholars—do not limit themselves to analytic rationality but draw extensively on their intuition (Dreyfus and Dreyfus, 2005). Traditional education still views rationality and the rational mode of thinking as the highest goal, and it should therefore be no surprise that despite continuing efforts to promote creativity in education, education is still dominated by standardized testing and that there is a crisis of creativity in doctoral studies. Real expertise draws on intuition and while integrating rational thinking involves being able to create as well as analyze. Experts, it turns out, are able to improvise, and the concept and practice of improvisation are very relevant to the future of education, the ability to address the unforeseen and the importance of creativity (Montuori, 2003).

Improvisation and Creativity

In recent years, the phenomenon of improvisation has begun to attract attention in disciplines from neuroscience to management. Musicians have been asked to improvise while being subjected to fMRI scans, and management theorists have argued for the importance of improvisational skills in a rapidly changing, uncertain environment. Along with jazz, improvisational comedy and theater have also begun to attract attention in the management literature. The root of the word improvisation comes from the Latin *improvisus*, or “unforeseen.” Improvisers are individuals who know how to deal with the unforeseen, and they also create the unforeseen. In an art form such as jazz, musicians are judged by their ability to create an aesthetic surprise in the moment, which is also why jazz is sometimes referred to as “the sound of surprise.” A historical detour is necessary to contextualize improvisation’s resurgence.

The term improvisation has an interesting history. In widespread usage, if someone has to improvise that is often used to mean that they were unable to perform the correct procedure, that there was a breakdown of sorts, and that they somehow had to make the best of a bad situation. Something improvised was mostly considered something second-rate, make-do, remedial, because the assumption was that there was always, in the words of management theorist Frederick Taylor, “one best way.”

When jazz first emerged at the beginning of the 20th century, many mainstream critics dismissed it as music made by people who did not know how to read music, and therefore just made something up. The musical score was seen to represent music in its highest and purest form, whereas performance was considered inevitably inferior and flawed. The dominance of this perspective, coupled with a good dose of racism, did not create a welcoming environment for jazz in high culture. As Prouty stated (Prouty, 2008),

(T)he idea that European traditions were believed to be of higher artistic quality than vernacular traditions (i.e., African-American traditions) is difficult to separate from the widely held assumption that composed music (well-composed music) was of superior quality to improvised music. Thus a rejection of jazz could be seen as one manifestation of a larger rejection of improvised traditions within American musical academia (and indeed, throughout the world, at least until recently) that has long been tied to the study of the western classical canon, with emphasis upon studying and performing the music of major composers (p.2).

It is therefore interesting to note that the rejection of improvisation is actually quite recent, and that the illustrious history of improvisation in Western traditions has mostly been swept under the rug. Until about 1800, there was a considerable amount of improvisation and embellishment in performances, both by soloists, whose cadenzas were improvised and by accompanists, who often provided improvised bass lines. Many of the great composers from Beethoven to Liszt to Scarlatti were renowned improvisers, and there were even improvisation contests not unlike “cutting contests” in the jazz tradition. The change can be traced back to around 1800 with three factors, namely the development of copyright, the image of the genius composer, and the importance of symphonic music performed by large orchestras (Goehr, 1992). The music of a great composer such as Beethoven was now completely written down and copyrighted, and could not be altered in any way by the performers. Symphonies were performed by orchestras with large numbers of musicians and as a result any improvisation could quickly lead to chaos. There are clear parallels between the emergence of symphony orchestras and the economic transition to the industrial age with increasingly large factories (Attali, 1985). The symphony orchestra had to perform like a well-oiled machine, and could not tolerate deviation from the score, both because the score was written by the composer and because in such a large ensemble deviation from the score could lead to chaos. Interpretation became the main avenue for conductors and instrumentalists to express their individuality, but the notes were now all the composer’s.

Improvisation is being appreciated and recognized for its value at a time when the traditional industrial model of organization is mostly viewed as outdated, when musical copyright (and indeed the music industry) is in crisis, and the traditional image of the genius is being re-evaluated. This development also points to the way that education in general, and not just musical education, has rejected creativity and improvisation. Improvisation is the ability to create in the moment, and for improvising groups, the process is the product. Traditional industrial organization and industrial education worked in a very hierarchical, top-down manner, with a focus on control, order, and prediction. Harold Geneen, President of IIT in the 1960s and 70s captured this with his classic motto: “No surprises!” Improvisation, on the other hand, functions from quite a different set of values and premises, and can better be explained using the language of complexity. In a jazz group, the music emerges from the interactions of the individual musicians, and while there may be one leader who sets the tone for the band, leadership is also determined by who is soloing at any given point, and surprise is arguably exactly the point.

The improvisational music found in jazz represents a form of organization based on a different set of values than the ones found in post-1800 Western classical music. These values stress the role of creativity and interaction between the musicians to a much greater extent and point to new social developments and changes in the understanding of creativity. In the last 20 years, there has been a growing interest in social creativity, which includes the creative interactions of musicians and actors. The return of improvisation reflects a paradigm shift and a return to performance, breaking down traditional dualisms of modernity between theory and practice, scholars and practitioners, and rigor and imagination (Donnelly, 2016). It also points to new possibilities in education, because the challenge of creativity in education goes beyond adding the odd creativity course, but rather reframing the curriculum and the educational experience to emphasize the centrality and pervasiveness of creativity in every aspect of learning.

Social Creativity for the Future

While innovation and creativity are daily nutrients among tech titans like Google and Facebook as well as with start-ups hoping to wedge a foot in the door of a multi-billion-dollar industry, creativity is also an essential element in an emerging constellation of approaches seeking to generate alternative, better futures. Creativity is now viewed not only as the province of exceptional individuals but also more relationally and collaboratively. Public and private efforts that seek to address complex, “wicked” social and environmental issues such as poverty, the opioid crisis, global food systems, education, population ageing, and health, among others are increasingly emphasizing the importance of processes involving social creativity.

The field of social innovation provides a counterpoint to the private sector focus on innovation for profit and the bottom line. It emphasizes the need for collective innovation and creativity to address humanity’s most pressing challenges. The most well-known but also critiqued examples of social innovation include microcredit (e.g. the lending of small amounts of money at low interest to new businesses in the developing world) and “fair trade,” (e.g. producers are paid fair prices for their product such as coffee and chocolate). A criticism of social innovation is that it can inadvertently redirect attention away from dangerous structural inequalities with an emphasis on individual and group empowerment culture, which in turn is part of the neoliberal orthodoxy that promotes deregulation and liberalization. And while this might be the case in how some social innovation efforts are positioned by governments, markets, and funders, social innovation’s orienting perspective does not shy away from deep, structural change. Many social innovators are guided by an understanding of social innovation as tackling root causes, of which governance and policy are essential aspects. Within the field of social innovation, social creativity approaches are applied toward systems change (structures) as well as social change (individual and collective behaviors and mindsets).

Many processes are emerging that can support collaboration across agencies, sectors and actors to address intractable issues. Theory U, Three Horizons, Transformative Scenario Planning, Social Labs, The World System Model, and Collective Impact are all methodologies that encourage collaboration and moving the needle on big issues. Facilitation methods to support the creation of generative gatherings and dialog are on the rise including Deep Democracy, Generative Dialog, World Café, Open Space Technology, and Circle Practice (a practice that is by all means not “new” but central in Indigenous traditional around the world).

One example of social creativity in action is *The Art of Hosting Conversations That Matter*, or simply *The Art of Hosting*. The Art of Hosting is an approach to leadership that scales up from the personal to the systemic, using personal practice, dialog, facilitation and the co-creation of innovation to address complex challenges. The Art of Hosting approach provides opportunities for participatory leadership and participatory leaders, what have been referred to, in the words of Margaret Wheatley, as the activation of “leader-full” communities and organizations.

These methods of dialog are not based on a worldview that subscribes to command-and-control leadership. Rather, they intentionally invite the emergence of collective creativity that can surface through integrating and even welcoming the chaotic, complex, dynamic messiness of human behavior and interaction. The Art of Hosting is a response to the awareness that no one leader, individual, government, organization, or nation can address, never mind solve, many of our social and ecological problems. The conversational methods used support environments that promote social creativity, and stress divergence as well as convergence, conflict as well as agreement. As planet-sized problems continue to disregard nations, borders, biospheres, and disciplines, the number of approaches with the purpose of creating generative, life-affirming futures continues to grow, and the challenge to mobilize creativity for better futures becomes ever greater.

Conclusion

Creativity changes the world and shapes the future, but creativity itself is in turn being shaped by the challenges of an emerging future. The creativity of modernity achieved tremendous advances and led to a great transformation and what we now think of as the modern world. At the dawn of the 21st century, the current crises—or rather the interconnected poly-crises—are leading to different understandings and practices of creativity: more contextual, relational, and deeply interwoven with social and ethical concerns. As the fascination with creativity in all aspects of society blossoms, there is an awareness that with greater creativity comes greater responsibility.

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Creativity Complex[☆]

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Glossary

Art bias A common mistake where creativity is thought to occur only in art. The corollary, equally mistaken, is that only artistically talented individuals are creative.

Complex A concept that is often used in clinical psychology and psychiatry to describe systems of interrelated characteristics that covary and are related to a particular psychopathology.

Disappearance of the problem Someone becomes so interested in solving a problem that it is transformed into a gratifying challenge and the person no longer views it as a problem.

Parsimony A guiding principle of modern science which emphasizes simplicity of explanation. All other things being equal, the simple explanation is best.

Syndrome A set of symptoms or indicators, often used to define or predict disorders or behavioral tendencies, and sometimes used to describe the creativity complex.

Introduction

Creativity has only been recognized as a fitting topic of scientific study for perhaps 60 years. There were several systematic investigations well before that – including Catherine Patrick's series of studies with artists and scientists in the 1930s – but archival analyses of publications and citations on the topic of creativity show that empirical work was sparse until the 1960s. There were several reasons for this. One is that creativity was (and often still is) equated with art. That in turn ties creativity to aesthetics and subjective processes that most scientists assume preclude rigorous science and best belong in the qualitative or nonempirical domain. The assumption that creativity is always tied to art is still quite common and has been called an *art bias*. It is especially problematic in education because it may lead teachers to assume that only students with clear artistic talents are creative. An educator who holds the art bias may not look for creativity in other students.

A second reason creativity was excluded from the behavioral sciences for so long is that it has varied etiology and is expressed in so many different forms and media. Studies of its etiology indicate that creativity is influenced by personality, cognitive and extracognitive processes, settings and culture, development, mood, attitude, affect, Zeitgeist, and perhaps even luck or chance. Its expression is at least as varied and includes all of the arts, but also technology, innovation, entrepreneurship, invention, and diverse sorts of problem solving. No wonder creativity has been defined, almost from the beginning, as a 'complex' or 'syndrome.'

This article reviews theories which explicitly define creativity as a complex. It also examines their assumptions and contrasts the definition of a complex with the opposite view, namely the *parsimonious theory of creativity*. Coverage is probably broader than may be suggested by the label *creativity complex*. That is because the creativity complex often goes by other names. *Creativity syndrome* was used in 1965 by Donald MacKinnon, a key figure in the early research done at the *Institute of Personality Assessment and Research*, and by Michael Mumford and Sigrid Gustafson in their influential article from 1988 in the *Psychological Bulletin*. Mumford and Gustafson also referred to *multivariate perspectives* on creativity. Then there is the idea of a *multilevel theory* of creativity. This is an attempt to emphasize the fact that creativity is often influenced by the individual, the immediate setting, and the general culture (be it organizational, geographical, or both). As we shall see when the advantages and disadvantages of the definition of creativity as complex are reviewed, the best label for the complex may be *multivariate*. That covers all of the different theories that explicitly describe the

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variety of influences and expressions of creativity, and it avoids unwanted connotations. More will be said about this below, after the facets of the complex are explored.

Defining Creativity

The research on creativity certainly does point to a large number of influences and correlates, some personal (e.g., affect, cognition, personality), some environmental (e.g., setting and resources), and some cultural (e.g., values and expectations) and interpersonal (e.g., encouragement and support). The idea of a complex recognizes each but also allows for diversity of expression, which is quite important given the differences among domains of creative endeavor and differences among kinds and levels of creative performance. Creativity can be expressed by a child, using his or her imagination, for example, but it can also be used by world-class experts when solving highly technical or far-reaching social problems. In slightly different terms, creative talent is often apparent in the lives of eminent persons, but 'everyday creativity' also allows each of us to deal with the hassles and surprises of our existence. In both cases original and effective ideas are used, so both qualify as creative behavior. The point is that creativity is complex both in terms of the antecedents and causal factors and also in its expression and the outcomes.

As a matter of fact the complexity of creativity is apparent even if the focus is on one particular creative event or product and not only when its diverse expressions are examined. That is because all creative things, be they inventions, innovations, works of art, scientific breakthroughs, or original solutions to everyday problems, share more than one attribute. There is one primary attribute, which is originality. All creative things are novel, unusual, unique, or in some fashion original. Originality is necessary but not sufficient for creativity. It is not sufficient for creativity because original things are sometimes not creative. Something may be original but useless, unrealistic, or ineffective. This is where the third kind of complexity comes in (to go along with its complex etiology and diverse expression): creative things are, at a minimum, both original and effective. Further, each of these two attributes can be defined in more than one fashion! An original thing might be entirely unique, for example, or it might be merely highly unusual. Even more to the point, the effectiveness of creative things may be determined in numerous ways. In the case of creative solutions to problems, effectiveness is supported by the fact that the creative solution actually solves the problem. But not all creativity involves problem solving. In the arts the effectiveness of creative things is typically aesthetic rather than purely functional. Along the same lines, creative art may be produced to express oneself rather than to solve a problem. Admittedly artists sometimes have problems finding the best ways to express themselves, in which case art could be seen as problem solving. Conversely, someone may be so interested in solving a problem that it is transformed into an enjoyable challenge and the person no longer views it as a problem. This has been called *the disappearance of the problem*.

Some definitions of creativity include a social component. The assumption is that things or people are only creative if an audience attributes creativity to them. Although many domains do in fact rely on audiences and social judgment, at least at the highest levels, there are serious problems with any definition that requires social attributions. It would, for example, exclude many everyday creative efforts, and these may by far constitute the largest of domain of creative expression. The idea of everyday creativity implies that creativity is a part of every person's life, everyday, rather than only being a part of the lives of professional creators or famous people. A social requirement would also exclude children's creativity, at least if it assumes that creative things must be original when compared to social norms and standards. Children may be original, in play or imagination, but much of what they do is original only on a personal level and not if compared to what others have done.

The real problem with a social requirement in the definition of creativity is that it confuses creation with judgment or reaction. To require that all creative things elicit social attributions would be a bit like saying that the speed of a runner depends on the stopwatch or accuracy of a timer. For the scientific study of creativity, it is best to keep creation separate from reception and from possible attributions. Those come after creation has taken place. For this reason the list of influences given below to exemplify creativity as a complex focuses on individual factors, such as cognitive talent or personality. It excludes social and cultural influences. These may actually influence creative efforts, especially if you consider that creative potentials are probably not developed unless they are valued by the culture and society in which they are expressed. Still, the focus here is on personal and intrapersonal influences and excludes social influences. Those could be addressed in a discussion of social judgments or audiences, where the focus is reaction not creation.

Creativity would be even more complex if social attributions were included in its definition, but any such definition would conflate creativity with fame, reputation, and impact (Runco, 1995). Quite a few social and cultural influences, including those experienced in the home, school, or work setting, are detailed elsewhere in this encyclopedia.

Diverse Influences on and Expressions of Creativity

The view that creativity is a syndrome or complex is justified by the fact that there are diverse influences on its development, diverse forms and media of expression, and more than one required indicator or criterion needed to identify creative things. Several criteria (originality and effectiveness) were mentioned above. Examples of the diverse influence and diverse forms of expression are equally easy to find. Several different kinds of cognitive capacity and skill have, for example, been associated with creative thinking. Creative thinking may involve imagination and insightfulness, for example, as well as a tendency towards divergent thought. Divergent thinking in turn is usually operationalized in terms of several kinds of ideation, including fluency, flexibility, and originality. Creativity seems to benefit from metacognitive processes as well, such as an intentional attempt to shift one's perspective or to put a problem aside to allow incubation.

Diverse cognitive influences on creative thought are also apparent in stage theories of the creative process. Wallas' four-stage model is the best known of these, though presented long ago (*The Art of Thought*, 1926). It includes preparation, incubation, illumination, and verification. More recent renditions include an implementation stage, which makes sense if the emphasis is on innovation or practical applications of creative thinking. A two-tiered model of the creative process includes many of the same stages but views preparation as a kind of problem finding. It divides this into problem identification and problem definition, which of course adds complexity. There is also an ideation stage, which is divided into those same tendencies mentioned above (fluency, originality, flexibility), and an evaluation stage, which may be divided into *valuation* and *evaluation* (the former being appreciative, the latter critical) and into inter- and intrapersonal judgments. The two-tier process model also recognizes the potential impact of knowledge and motivation, and as you might expect divides each of these into specifics. The former includes procedural and declarative (or conceptual) knowledge, and the latter includes intrinsic and extrinsic motives.

Various *cognitive styles* have been associated with creative thinking. There is, for example, empirical data distinguishing assimilator, innovator, adaptor, and explorer styles, just to name some of the more commonly used. Even the long-standing style theory that contrasts deliberate with impulsive cognitive tendencies has been associated with creative thinking. The theory of creative styles is especially relevant because it assumes that there is more than one way to be creative. Unlike theories of ability, which frequently assume that there is one dimension and that people either have a high or low level of that one ability, theories of style agree that there are different paths to behaving creatively. The focus in theories of creative and cognitive style are on "how" rather than "how much."

Complexity is further suggested by the fact that creative thinking differs with the domain or subject matter. Creative thought can draw on verbal skills, but it may also rely on imagery, preverbal processes, and 'preinventive forms.' Because many of these differences in the mode of thought can be understood as domain differences, more will be said about them below, in the section on diverse expressions of creativity. At this point it should be clear that, even within the cognitive category of influences, there are numerous possibilities. The concept of a complex thus makes sense.

The same is true when considering the influence of personality on creative efforts. The most important personality traits for creativity seem to be openness, autonomy, wide interests, flexibility, and intrinsic motivation. The last of these suggests that there are motivational and therefore affective bases to creativity. Plenty of research indicates that mood influences the thinking tendencies that support or inhibit the likelihood of finding original insights. And it is not a simple thing: on some tasks it seems to be helpful to be elated or happy. This can lead directly to an appreciation of a wide range of options and new possibilities. But some tasks seem to benefit from the darker moods.

Attitudes also play a role in creative efforts. Again, there are a number of different possibilities, including openness to divergence – which fits well with theories of divergent thinking – playfulness, and tolerance. There are also attitudes which most likely inhibit creative behavior, including tendencies towards *satisficing* or premature closure. Note here the idea that there are supports for creativity as well as probable inhibitors. This same dichotomy applies to virtually all influences, be they cognitive, personality, attitudinal, affective, or whatever. It may not literally double the complexity of creativity, but it certainly does dramatically increase the range of influences.

The diverse expressions of creativity, which also help explain why it is viewed as a complex, are very easy to summarize. Much of the early research on creativity – including that mentioned above and conducted at the *Institute for Personality Assessment and Research* – involved writers, architects, and other professional groups, and data supported the idea that the requirements for creativity differ from group to group (and domain to domain). Howard Gardner's theory may be the most formalized delineation of domains. It includes verbal, mathematical, spatial, bodily-kinesthetic, intrapersonal, interpersonal, musical, and naturalistic domains. Gardner argued convincingly that these differ from one another in their biological, developmental, and cognitive bases. His is not a theory just of creativity but subsequent research with creative samples has largely supported the same set of domains.

Subdomains are also described in the creativity literature, and they too imply that creative talents can be expressed in diverse ways. Even in an area such as language there are differences between poetry, drama, novels, speeches, lyrics, jokes, political spin, and oral communication, just to name a sample of what might be called verbal subdomains. The various sciences also differ, especially if the hard sciences are contrasted with the social sciences. Ask any scientist and they will probably be able to point to numerous idiosyncrasies of their particular field. Then there are the different possible expressions of creativity at different ages, as implied by what was said above about children's creativity. Add to that the "old age style" of highly creative artists and the expressions of creativity late in life.

One of the clearest examples of diverse expressions of creativity are those identified in the work on creativity in the moral domain, which includes both humane and benevolent creativity but also, at the opposite extreme, malevolent creativity and the "dark side". This work is especially interesting because the dark side is currently so obvious in the political realm (at least since November 2016) and has such broad implications (e.g., debates about the climate crisis which include arguments that have no basis in fact but are clearly politically motivated). Studies of benevolent and malevolent creativity point to the significant role played by intentions (Runco, 1993), but what is most relevant here is that creativity in the moral domain covers the full range, from benevolent to the opposite, the malevolent.

Although there is a bit of discussion in the creativity research about the possibility that there is a commonality among domains and all possible expressions (i.e., a kind of "general factor" underlying all creativity), that would not really eliminate the obvious fact that creativity takes many forms. At most, if a commonality is uncovered, it would mean that there are both similarities and differences among domains and the possible expressions of creativity. Thus, given its etiology (e.g., the influences mentioned above), the multiple criteria used to define it, and its varied expression, it is easy to see why it is so common to view creativity as a complex.

Parsimonious Creativity

The definition of creativity as a complex is consistent with much of the research on the topic and has a number of advantages. It applies very broadly, for example, as is apparent in the long list of influences and diverse domains of expression mentioned just above. Yet there are also disadvantages. One is suggested by the connection of 'complex' and 'syndrome' to psychopathology. These two labels are in some ways applicable to creativity—they both imply that there is a set or system of relevant symptoms and indicators – but those same labels frequently connote psychopathology. Given misconceptions of the association of creativity with psychopathology (e.g., the creator as 'mad genius' or necessarily bipolar or suicidal), this is a potential disadvantage. That is one reason why earlier I suggested that it may be best to view creativity as *multivariate* in its etiology and expression. That label allows for a set of indicators but does not have the same connotations as *complex* or *syndrome*.

A second concern with the creativity complex is more significant. This reflects what is inherent in any complex: it is complicated. More to the point, it is not *parsimonious*. Parsimony is an important part of all sciences. It requires simplicity of explanation. All other things being equal, the simple explanation is best. Is a parsimonious definition of creativity possible? To define creativity in this fashion, there must be something common to all creativity.

It may be difficult to see what is common to all creativity, given all of the various influences and diverse expressions (e.g., domains and differences at different ages). Perhaps a commonality can be found if one step is taken at a time, to narrow the field and remove each unnecessary part of the complex in a systematic fashion.

The first step towards parsimony is dictated by the scientific concern for *causality*. Without a doubt, at the heart of all scientific theories is an interest in uncovering actual explanations for events and actions. Good science does not merely describe; it also explains, and a good explanation must identify specific causal factors. This is why experimental research is so highly respected: it eliminates confounding factors and nuisance variables so true causes can be unambiguously tied to effects. A parsimonious theory of creativity should focus on explanations rather than descriptions. It must identify causes, or what are sometimes referred to as the mechanisms that are responsible for creativity.

Thus the first step towards simplifying the complex involves eliminating effects of creativity from its definition. These may be interesting, and socially or personally useful, but they are not causes and not really explanatory. A great deal of the creativity literature describes effects, and all of those findings can be eliminated for a parsimonious definition. Effects are on the wrong side of the causal equation and thus do not advance the parsimonious theory of creativity. Certainly causes can sometimes be inferred from effects, but it may not be necessary to resort to such inferences.

As a matter of fact, many of things that make creativity seem complex are effects of creative processes. As such they make themselves known only after creativity has occurred! Recall here that social definitions of creativity were dismissed above because they are reactive and not a part of the actual creation (i.e., when something new and useful is brought into existence). Other effects and results include the products which are so often studied in creativity research. They too can be put aside since they do not offer direct information about causality. Creative products are original and useful, and they may be highly desirable, but they do not explain creativity. They are results or outcomes, not causes. They cannot be manipulated to control the creative process, and any theory based on them is post hoc and much more descriptive than explanatory. It will also lack generality, given that many creative experiences do not lead to a lasting product. Think here about how reputations and judgments of creativity change, especially over long periods of time (Runco et al., 2010; Runco et al., 2016).

A second but more difficult step towards parsimony involves putting aside all 'mere influences' on creativity. Influences can be dismissed because they offer no guarantees. They are not really determinants. Influences may have some impact, but that is not the same thing as being causally required. Mere influences are much weaker than actual causes, much less reliable, and insufficient as scientific explanations. Think back on the influences reviewed above, when the theory of a creativity complex was being outlined. Consider each of these individually and ask, does all creativity depend on this influence? Does all creativity depend on, say, intrinsic motivation? It does not; there are many cases where extrinsic incentives are involved. Is all creativity a result of a particular mood, or even dependent on a particular cognitive process? Far from it: for some tasks, one mood seems to be best, while for others, another mood is conducive to creativity. Or it may be that the most supportive mood varies from stage to stage of the creative process. The same thing can be said about cognitive processes. In fact it can be said about all potential influences. They do not apply all of the time.

Creativity can be defined parsimoniously if it includes only what is always vital and necessary. All else is extraneous. This allows us to exclude even more than products, effects, outcomes, and results of the creative process. The literature on influences probably constitutes the largest portion of creativity studies. And like the research on products, it is useful. It may suggest how to make creative activity more likely, for some people, some tasks, some of the time. But a parsimonious definition of creativity includes only what is necessary, not just what is sometimes influential. A parsimonious definition excludes outcomes because they occur after the actual creation, and it excludes mere influences because they are not always involved, and thus not vital, as would be expected for a causal explanation.

There really is very little that is vital and necessary for all creativity. In fact, the only things that are universal and necessary were mentioned above. They are (a) originality and (b) effectiveness. Granted, there is variation in the wording. Sometimes originality is labeled novelty, for example, and sometimes effectiveness is labeled adaptiveness, fit, utility, or appropriateness. Whatever the label, originality and effectiveness are vital for all creativity. This is not all that constraining, either. Originality and effectiveness apply to

all domains and all categories of research. Thus (a) creative products are original and useful; (b) creative persons have the capacity to be original and find or produce useful things; (c) creative places are those that support the production of original and useful things; and (d) the creative process is apparent when a person is progressing towards something that is original and useful.

The objective of a parsimonious theory is to keep things as simple as possible. That does not necessarily mean that everything is removed and excluded, one by one, until only one causal factor remains. Obviously the epitome of parsimony would be a theory which points to one causal factor that explains everything. But parsimony can be taken too far, in which case it loses its value. If too much is removed, just for the sake of simplicity, accuracy and understanding are lost and parsimony has done science a disservice. Even though the method used here, which excluded influences and factors which do not apply to all creativity, only reduced the list to two requirements, originality and effectiveness, this may be the best we can do. It may not be possible to distill theories any further, at least if we wish to accurately understand true creativity. But a two-factor theory of creativity is much more parsimonious than those relying on the idea of a creativity complex.

Conclusions

The idea of a creativity complex is in some ways useful. It suggests that original and effective behavior in diverse domains can all be considered under the general umbrella, 'creativity.' It offers breadth. It is good that we see creativity in various domains and appreciate the diverse expressions of creativity.

There are, however, several problems with the idea of complex. One is just semantic – the connotations of the labels complex or syndrome. The other is much more significant. It implies that studies of creativity are still not entirely scientific. After all, the sciences focus on causality and value parsimony, and the creativity complex is nearly the opposite of parsimonious and includes many things that offer little or no causal information.

The scientific requirement of parsimony is usually taken to mean that, when there are various explanations for some phenomenon, the simplest one is best. That in turn supports the parsimonious theory of creativity which only includes originality and effectiveness. Parsimony requires that everything that is not vital is excluded. This really just means that the creativity complex can be simplified if the focus is on that which is involved in all creativity, not just involved in some creative things.

The idea of a complex would seem to be untenable according to the primary goals of science, which are prediction and control. These two things, prediction and control, were used by B. F. Skinner as standards of rigorous science. Think of the numerous important benefits of creativity if it could be accurately predicted and controlled. Those make the parsimonious approach to creativity all that more attractive.

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Creativity Gap

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Introduction

Parallel to increasing importance of innovation economy and accelerating speed of change, public interest in creativity has also increased. As of December 2018, the most popular TED talk is about creativity (Robinson, 2006), which inquired how schools influence creativity. Newsweek and Time magazines released special reports on creativity and explored the reasons behind cross-generational declines (Bronson and Merryman, 2010) as well as the means to enhance it (Time, 2018). A common theme across various popular talks on creativity is that everybody has creative potential and creativity is an important asset to individuals and for society. Failure to fulfill one's creativity is a loss at both levels. The argument follows as such: if everybody possesses creativity, why are some people more creatively accomplished than others? What prevents a full-expression of creative capacity?

The concept of creativity gap is central to these questions. The *creativity gap* refers to the level at which one underutilizes his or her creative potential. To understand one's creativity gap, it is important to look into creative potential that is yet to be actualized and the actualized creativity. The sum of the two would be a perfect transformation of creative potential into creative performance, which would reflect an ideal state where people reach to the full potential of their creativity. In reality, the former may be higher than the latter, reflecting the least ideal state compared to the other way around, at which people actualize their creative potential to some degree but there is still more to fulfill.

Creativity Gap as the Discrepancy Between Creative Potential Versus Creative Performance

Conceptually, the most relevant connection to the creativity gap is the distinction between creative potential and creative performance (Hinton, 1968). Creative potential refers to the skills, abilities, and attitudes that lead to creative behavior whereas creative performance is the actual creative output. Creativity gap increases as the proportion of creative performance to creative potential decreases. This distinction has implications for the measurement of creativity as well. Measuring creative achievement seems to be more objective and easier to capture through testing than measurement of creative potential which is more elusive and inclusive of multiple constructs. However, focusing on the measurement of creative potential may preferable to measuring creative achievement because creative potential may be less influenced by societal factors including socio-economic status than the creative achievement. Measuring both would help reveal creativity gap by identifying the points of discrepancy.

Mark Runco (2003, 2004) has used this distinction quite often and argued that education should focus on creative potential because creative performance requires more than creativity itself (e.g., social expression and recognition). A person is still creative when a creative idea has not been transformed to creative outcome or when a creative outcome has not been validated by others yet. Creative performance is influenced by additional factors such as chance, socio-economic status, and resources. Presence of such additional factors may conceal the essential quality in the creative process that is the creative potential and the educators should pay more attention to this essential quality. This logic is consistent with his emphasis in "personal creativity" which is different than "socially recognized creativity". The personal creativity often focuses on *process* whereas socially recognized creativity focuses on the *product*. Personal insights and interpretations are considered part of personal creativity whereas a finalized outcome is at the core of socially recognized creativity.

As stated above, creative potential is crucial for personal fulfillment. Nevertheless, it is difficult to define conceptually and to observe empirically. To complicate things further, another distinction was made between creative potential and practiced creativity (DiLiello and Houghton, 2008). The latter focuses on the *perceived* opportunities to utilize creative skills and abilities on a specific task. Creativity is associated with thinking without limits, whereas almost any organization in the world, be it a school, government office or private corporation, has some kind of structure that imposes certain limitations to those in the organization. Creative people may often feel confined and repressed when their talents are not channeled, expressed, and challenged. When one believes

creativity is not expected or desired, he or she is less likely to engage in a creative behavior (Ford, 1996; Tierney and Farmer, 2002; Farmer et al., 2003). This difference is important because creativity gap may emerge at a personal level when a person starts noticing the lack of means for practicing what he or she possesses.

The word “perception” is critical in practiced creativity and is subjective. Indeed, the same environment may be perceived as conducive to creativity for one person but not for another. Yet, to some degree such perceptions are rooted in the characteristics in the environment. Feelings of restrictedness or confinement are more likely to occur when the work or school climate is not supportive of creative characteristics than not. Therefore, there are ways to reduce creativity gap that is related to the perceptions of the individuals, which will be discussed in a later section.

The concept of creativity gap is directly related to some key concepts in humanistic psychology. Broadly speaking, elimination of the creativity gap implies becoming a self-actualized person, in Maslow's (1974) terms [see Self Actualization, this volume]. His thoughts on creativity seems to reflect the distinction between creative potential and the creative performance. Maslow himself distinguished *self-actualizing (SA) creativeness* from *special talent creativeness*. SA creativeness is about creative personality rather than its achievements. It consists of many personality-related qualities such as freedom, courage, and spontaneity that permeates all aspects of life rather than serving as a problem-solving or product-development tool alone. Therefore, SA creativeness is more about “Being” and “Doing” and the creativity gap is about overcoming barriers for such a person to come into Being.

Creativity Gap as the Discrepancy Between Formal Versus Informal Settings

Another way to look at the creativity gap is to compare creativity as demonstrated at formal versus informal settings. As discussed above, schools or workplaces may be confining to the individuals with a high level of creative potential as a result of rules, procedures, bureaucracy, protocols, lacking resources and time, the nature of goals and priorities determined for the organization, the emphasis in efficiency and productivity, or organizational culture and tradition. Therefore, individuals may feel like they have to comply with the organizational expectations rather than influencing the organizational culture to make a space for their personal expression of creativity. According to Adobe's 2012 Global Survey of Creativity with approximately 5000 adults in the developed countries, only one in four people believe they can actualize their creative potential although more than two-thirds believe creativity is critical to economic growth and its value for the society. They think productivity is more desirable than creativity at work and most think that schools suppress creativity. Therefore, highly structured environments such as most workplaces or schools may not be the best setting for observing personal creativity. Natural expression of creativity more likely to appear in informal settings where people are in control of their time and resources.

Observing creativity demonstrated at formal settings such as the workplace or school versus informal settings such as at home, interest or hobby groups, or vacation is another way to get at the creativity gap. People can resort to their creativity at informal settings that they are unable to use in the formal settings. Therefore, comparing creative activity inside and outside the workplace or school may capture the creativity gap. This is how Mark Runco et al. (2017) operationalized the creativity gap in the school context. This study is built on the earlier work by John L. Holland (1961) who found that academic achievement and creative performance are largely unrelated because factors leading to the two differ from each other. Academic achievers tend to be serious, responsible, rigid, persistent on their goals, conforming to the rules and expectations. They tend to have authoritarian parents and be more favorable to the teachers (Holland, 1959). Creative people tend to be original, independent, and open to experiences and their parents are more permissive. Holland's later work (Holland and Richards, 1965) also found that academic and non-academic (extracurricular) accomplishment is independent of each other. Extracurricular accomplishment consists of different forms of creative activity such as drama, science, arts, or business. Academic achievers and creative achievers tend to be different people or being a high achiever in one does not imply being a higher achiever on the other. This may explain why some garage entrepreneurs are not high academic achievers (a.k.a. the garage belief). As a result, Holland argued that most traditional schools may hinder, rather than support, creativity. Then, a garage is an example of informal, unstructured setting where creativity is put into practice without many of the external constraints on personal expression of creative potential.

Runco et al. (2017) revisited Holland's findings after 50 years. They asked the college students to indicate their creative activities and accomplishments as demonstrated inside versus outside the school. Similar to Holland's findings, the relationship between the two is mostly small or negligible. Moreover, creativity activity was significantly higher outside the school than inside the school. They went further and explored the reasons behind this creativity gap. They regressed that creative activity outside the school on creative activity inside the school to obtain the creativity gap. Next, they explored several predictors to explain the variation in creativity gap and found that creativity gap tends to be higher for those who have positive attitudes and values toward creativity, higher creative personality, and prefer working in solitary rather with others. These results are eye-opening because restrictions in the formal settings are more likely to limit those who have greater creative potential than others. Consequently, creativity gap seems like a bigger threat to them.

Creativity Gap as a Failure to Commercialize Ideas That Can Be Commercialized

Creativity has much to do with ideas. Any creative product or outcome was once seeded as an idea. Generation of an idea, noticing the potential in it, and the implementation are different processes. A successful creative process includes all of these steps to be attended. There may be situations, in which a creative idea is generated but not noticed or implemented. According to Maksim

Belitski and Sameeksha Desai (2016), creativity gap emerges when a greater (more selective) creativity filter is used to choose ideas to turn to product. Creativity filter refers to the decision-making mechanisms that select certain ideas over others to commercialize under uncertainty. So, the ideas that deserve to commercialize, but are not, lead to a creativity gap. The higher the difference between actualized commercialization of creative ideas and potential ideas to commercialize, the larger the creativity gap.

The decision to commercialize a creative idea is an important step and this may be the key factor to successful start-ups. According to Robert Sternberg and Todd Lubart's (1991) Investment Theory, creative people are good at recognizing and investing in creative ideas. Those people tend to "buy low and sell high". They identify the potential promising ideas that are not recognized by others (i.e., buy low) and improve and refine them to enhance their usefulness and marketability to others (i.e., sell high). This theoretical perspective may be considered along with Csikszentmihalyi's (2014) Systems Theory, in which creativity of an idea is facilitated and compromised by the field and the domain. Although, some people are better "investors" than others, the final success of a creative idea requires factors outside of the individual. The investment capability is complemented by other key players or gatekeepers in the field who determines what ideas have a promise. Putting these two theories together, creativity gap related to the failure to commercialize an idea may be attributed to both personal and environmental factors. Some people and contexts are more open to creative ideas than others and this openness reduces the creativity gap. According to Belitski and Desai, creativity gap (so, creativity filter) diminishes with more entrepreneurship. More entrepreneurship means more ideas to test out and more risk-taking on potential ideas. As more ideas are tested and commercialized, the probability of "false negatives" (i.e., failure to detect a promising idea) is reduced. A possible negative consequence of this is higher rate of failed start-ups—the investments that do not bring returns. Because of over-inclusive selection, the "false positives" (the selection of ideas should not have been selected) will also increase.

Belitski and Desai found that entrepreneurship (the density of start-ups) moderates the relationship between creativity (the proportion of the creative sectors) and urban economic development. In other words, existence of start-ups facilitates those in the creative sectors to contribute to the economic development. Those start-ups reduce the creativity gap by providing an outlet for the creative people to transform their potential into performance.

The Creativity Gap as the Discrepancy Between the Perceived Value of Creativity Versus Commitment to Creativity

Some researchers used the term "creativity gap" to describe the inconsistency between the perceived value of creativity and commitment to it. The value of creative thinking is obvious to so many, however, acknowledging its importance does not always follow actions to prioritize it in the workplace or schools. After all, creative thinking involves risk-taking, change in habits, delay of gratification, and tolerating ambiguity and these are viewed as luxurious for some people or organizations. This kind of creative gap refers to the distance between where most organizations are and where they want to be. This disparity between the reality and vision is observed in different sectors such as healthcare and education. For example, PricewaterhouseCoopers' (PwC) Annual Global CEO Survey revealed that 79% of the corporate executives believe innovation leads to higher revenues with increasing efficiency and superior growth whereas active investment in innovation does not follow closely.

Matthew Makel (2009) points out this kind of creativity gap in education. Creativity is highly praised and valued by many educators but it is mostly absent in the classroom. He suggested that changes are needed in educational policy, societal values toward creativity, teacher training, creativity researchers' level of engagement in educational practice, advocacy projects, and change in language that emphasizes the need for encouragement of creativity rather than enhancement of it. He highlights the importance of preparing the youth for the creative age where transmission of the information is less important than the way it is used. According to Makel, the strategies to close the creativity gap in education includes eliminating the difference in the context of learning and application. When the context of learning and application differ from each other, students may not be able to transfer the learning to a new context. He also criticizes the current educational policy for lacking a creative pedagogy and overemphasis in standardized testing. Another problem with this approach is that it prioritizes the short-term gains (success on tests) rather than long-term goals such as developing students' creative thinking. He argues that this system may penalize teachers who prioritize creativity development.

The difference between the value of creativity and commitment to it may also stem from the limited understanding of the concept of creativity or misconceptions around it. Although creativity is a positive quality for many people, some traits of creative individuals may be hard to manage or tolerate in the classroom context at least for some teachers. Those characteristics include independence in thinking and behavior, challenging the authority and status quo and autonomy. Students with these traits may easily be perceived as disruptive and annoying. This is why John Holland (1959) warned about teacher ratings as a questionable predictor of creativity. More recently, Erik L. Westby and V. L. Dawson (1995) found that teachers' favorite students may not be the creative ones and those who display creative characteristics may not be welcome by them. Christina L. Scott (1999) compared teachers and college students' perceptions of creative students and they found that teachers are more likely to find creative students as potentially more disruptive than the college students. She argued that there may be a bias against the creative students in the classroom as they have difficulty in following the rule and showing compliant behaviors.

Bias against creativity is not limited to teachers or education. Jennifer S. Mueller, Shimul Melwani, and Jack A. Goncalo (2012) explored why some people tend to reject creative ideas even though they indicate creativity as a desirable thing. They found that people tend to prefer practicality over creativity during the times of uncertainty. They argue that the bias against creativity is an implicit one and may prevent a person from recognizing the potentially creative ideas. In later research, Jennifer S. Mueller et al. (2011) found that those who suggest creative ideas are less likely to be perceived as having leadership potential unless the person

suggesting them is a charismatic leader. [Young Soo Lee et al. \(2017\)](#) investigated the emotional reasons behind the implicit bias against creativity and found that people experience fear when there is a highly uncertain situation and tend to rate an idea as less creative than low-uncertainty situations that trigger happiness or anger.

Creativity Gap as Differences Across Regions and Cultures

Creativity may be expressed more in some places than others. The differences in the expression of creativity may occur factors beyond the individual such as cultural values, parenting, educational system, and opportunities and resources available. [Yong Zhao \(2008\)](#) used the concept of “creativity gap” to describe American superiority in creativity over Chinese and explained the difference in terms of collectivist values that demand conformity, parenting practices that overemphasize external standards of academic success, and standardized and centralized educational system that leave little room for flexibility around the established norms and rules.

The same line of reasoning may be extended to different regions of the same country or a particular cultural group. [Cynthia Negrey and Stephen D. Rausch \(2009\)](#) used the term “creativity gap” to describe regional differences in creativity across different parts in the United States. Their work relies on [Richard Florida’s \(2002\)](#) work on the Creative Class. Florida argues that creativity is the key to economic development and those who belong to the creative class are the ones who use their mind rather than their physical capacity. They develop intellectual products rather than physical products. Creative places are those that more of people in the creative class live. He argues that creative people are drawn to the places like that. Other major three characteristics of the creative cities include technology, talent (proportion of educated people), and tolerance (openness to diversity). Based on these factors, Florida identified the most and least creative cities across the US cities.

Florida’s work was criticized for ignoring socio-economic factors, which was also found to be influential on creativity. [David Yun Dai and his colleagues \(2012\)](#) defined the creativity gap as differences in creativity led by socio-economic status (SES). They found that socio-economic status (SES) and parental education explain part of the discrepancy in creativity. Students of the high SES families and educated parents performed higher than low-SES families and less educated parents.

Creativity Gap as Temporal Differences

Creativity does not follow a linear pathway according to some research. Some periods in history witness more creativity than others. Using [Urie Bronfenbrenner’s \(1994\)](#) terminology, the chronosystem may lead to the creativity gap. [Berys Gaut \(2010\)](#) refers to creativity gap as such temporal changes across ages and explain improvements over time as a result of the increasing population density that lead to better preservation of creative outcomes. [Dean Keith Simonton’s \(1975\)](#) historiometric studies also reveal some of the mechanisms underlying greater creative activity. He found that creative development is positively influenced by role model availability, political fragmentation, and revolutions or revolts and negatively influenced by political instability.

Closing the Creativity Gap

The above discussion on creativity gap alluded to some of the factors leading to it. Some of these factors are internal and some are external. Internal factors include attitudes and values toward creativity, implicit bias against creativity, limited understanding of creativity, self-imposed constraints, personal mindset, conventionalism and conservatism as opposed to openness, and avoidance from uncertainty and risk. External factors consist of cultural values that prioritize social approval and expectations, conformity, social norms, rules and regulations, bureaucracy, SES, and lack of time, resources, and opportunities.

Those factors also provide clues about the ways and strategies to close the creativity gap. Broadly speaking, any intervention or condition that allows and encourages creative expression helps to close the creativity gap. The training programs that develop personal awareness and knowledge on creativity, emphasize attitudes and values that support creativity, explore personal habits, blocks, and self-imposed constraints are particularly important for closing the creativity gap. Such programs may be viewed as a way to recapture creative potential that tends to disappear with aging, certain educational practices, environmental restrictions, and social expectations.

Environmental restrictions may also be overcome through effective leadership. As [Trudy DiLiello et al. \(2011\)](#) indicated, one way to reduce the creativity gap is to change the perception of environmental support. They found that those people who have high creative self-efficacy and perceive support for creative behaviors are more likely to engage in creative activity than those who do not perceive such support. Creative potential is more likely to translate to creative outcome when support and encouragement are offered.

Closing the creativity gap may be easier now than the past because of technological advancements and available resources and opportunities. Technology removes many of the existing barriers against creativity by allowing faster exchange of knowledge and greater network among the experts and creative agents. Computer and internet technology, more specifically, social media have become a major source of inspiration and knowledge dissemination. Through technology, people may keep up with the most recent developments and build on the existing knowledge and elsewhere.

Creativity benefits from resources and opportunities. Lack of resources, opportunities, and time are most frequently identified blocks to creativity. This is why some organizations are more deliberate about supporting creativity through specific units

designated for creative activity and research and development. Creativity labs, business incubators, makerspace, innovation garages are some examples of such places.

Entrepreneurship is another solution to the creativity gap. Entrepreneurs are the ones who identify potential ideas to grow, invest in those ideas, and turn them into something profitable and beneficial. They literally “buy low and sell high” as was described in Sternberg and Lubart’s Investment Theory. As more entrepreneurs try out new ideas and possibilities, more of the creative potential is put to practice and experimented. Creativity gap, that is fundamentally about unfulfilled creative potential, is thus closed.

Conclusion

Creativity gap has been defined and used in different ways in the literature. However, these conceptualizations share one thing in common, which is the amount of unfulfilled potential to create. Creativity gap is higher when one does not live up to his or her creative potential. Creativity gap indicates how much a person is away from actualizing oneself. This gap may show itself in certain time periods, on a specific region, or under certain contexts such as informal settings. What amazes most people about creativity is its representation as a final product, which may take the form of a groundbreaking artwork or innovation that changes the way we live and perceive the world. What should be frightening to an educator or leader is the creative potential that was ignored, unnoticed, unrecognized, or untapped. A primary purpose of education and leadership at any level should be to reduce this creativity gap.

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Creativity Models

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Creativity Models in Contemporary Psychology

History is contemporary in the sense that it is out of history that any contemporary society grows. Although history seems like a fact-based and past-oriented field, it is also always discussed in the present with an implicit view to the future. History must be ecologically distilled to be ingested, hence someone has to select which qualitatively or quantitatively impactful events are part of it (Carr, 1961). Consequently, the interpretation of historical events can and does change based on context. For example, Columbus day (i.e., a national holiday to celebrate Christopher Columbus's arrival in the New World, Americas), while celebrated by some, can be insulting for certain groups of people (e.g., native Americans).

Similarly, creativity models can be curated in numerous ways based on the aspect of creativity a scholar focuses on (e.g., levels of creativity, domains of creativity, creativity components, and relationships between individuals and environment). In this entry, creativity models are chronologically introduced since 1950, which is time when explicit, empirical creativity research began, at least conventionally. In 1950, less than 2 in 1000 of the listings in *Psychological Abstracts* were related to creativity, and this rate increased to about 10 in 1000 by 1980 (Amabile, 1982). Although the roots of creativity conceptions can be different depending on culture (Niu and Sternberg, 2006), the relatively parsimonious definition of creativity used in scientific research is based on producing something new and task-appropriate (Hennessey and Amabile, 2010; Kaufman, 2016). This operational definition is also shared in studies from many cultures.

Unfortunately, not all creativity models are included in this entry. However, the authors acknowledge that they are part of the incremental development of the field of creativity. Possibly, knowledge about world history and events may be helpful for finding patterns when reading the creativity models discussed below.

The 1950s

In the 1950s, the cognitive processing framework had a great influence in creativity research. Before this information-processing perspective, Wallas (1926) had already developed his individual creative stage model, consisting of five steps: preparation, incubation, intuition, illumination, and verification. Guilford's (1950, 1967) Structure of Intellect (SI) model was conceived to be an approach to intelligence, but his model had a significant impact on creativity due to its proposal of divergent thinking and convergent thinking. These two types of cognition became the foundations of the most routinely used creative test: The Torrance Tests of Creative Thinking (Torrance, 1971) which was utilized, for instance, in approximately 15.3% of the US elementary gifted education programs (Callahan et al., 2013).

Alongside the individual mental processes of creativity, group creativity was also an area of interest. Alex Osborn's (1957) Group Creativity is based on the assumption that creativity in a group can be fostered through strategies such as brainstorming. Despite his argument of the effectiveness of brainstorming and its popularity, other research does not support it (Diehl and Stroebe, 1991). Especially when an employees' cognitive style is systematic (e.g., logical rather intuitive), a brainstorming-like unstructured approach decreases rather than increase creative idea generation (Sagiv et al., 2010).

Another concept present in early models of creativity is that of creative domains. Snow (1959) conceptualized two dichotomous domains, art vs. science. Architects were often studied in this context since architecture is believed to require both artistic and scientific creativity (Hall and Mackinnon, 1969; Mackinnon, 1962). A related distinction is represented by Cropley and Cropley's (2009) functional and aesthetic creativity. Furthermore, creators in the arts and sciences can display somewhat different personality traits; artists are more likely to be emotionally unstable and disagreeable than scientists (Feist, 1998). Extraversion, as an independent factor, significantly predicted creative achievement only in the arts (Kaufman et al., 2016). Even within the two-broad themes, there are some personality differences within domains. For example, performing-art students were more extraverted than visual-art

students (Silvia et al., 2008); creative scientists are more extraverted and less disagreeable than less-creative scientists (Feist, 1998). The Kaufman Domains Of Creativity Scale (Kaufman, 2012) is a more recent example of adopting the artistic and scientific domains of creativity model and extending them to more areas: Scholarly, Self/Everyday, and Performance. Domains of creativity will be revisited and discussed later in this entry.

The 1960s

Rhodes (1961) organized the creativity studies up to that time into four major categories: person, process, product, and press (environment). This model is called the Four P's and has influenced how creativity researchers conceptualize the phenomenon and the kind of questions they systematically ask: What are creative people's characteristics? How do people successfully create? What are the criteria for creativity? How does environment affect creativity? Later, Runco (2003) and Simonton (1990) respectively argued that adding *potential* and successful *persuasion* is important for creativity research beyond the Four P's Model. Although *potential* and *persuasion* can be part of creative *people* and the creative *process*, respectively, they both can be independently significant since *potential* values intrapersonal creativity and *persuasion* values sociocultural interactions with others in the creative process.

Campbell's (1960) Blind Variation and Selective Retention (BVSR) tried to explain the individual creative thinking process, embracing individual differences. It is different from pure cognitive problem-solving perspectives (e.g., the mechanical trial and error problem-solving mechanism) in that BVSR embraced insight, the powerful influence of the environment on creative thought processes, and drew inspiration from biological theory (i.e., Darwin's natural selection). Simonton (2010), recently argued that BVSR could explain many dimensions of genius-level creativity after comprehensively reviewing Campbell's theory. Although it is controversial whether the variation is blind or random (Kronfeldner, 2010), evolutionary variation-selection perspectives are still useful to understand creativity in contemporary neuroscience (Dietrich, 2019).

Mednick's Associate Theory (1962) has a different root than Guilford's idea generation and evaluation although his Associate Theory explains an individual thought-process similar to Guilford's. Mednick emphasized the cognitive ability to connect remote concepts to generate original ideas. For example, the word, "fish" may commonly help British people come up with the word "chips." More unusual answers, such as "sauce" and "church" would be considered as more creative or indicating of creative potential. However, using the same example, many Vietnamese would associate it with "sauce" since fish sauce is a critical ingredient. Also, pious Christians could easily connect it with "church" due to the historical symbol. This example demonstrates the impact of individuals' background factors (e.g., language skills, knowledge, and culture) on their association ability, as a creative thinking construct. Consequently (and also for other reasons), measures of the remote association theory do not have a robust validity when it comes to creativity (Shen et al., 2016).

Whereas most cognitive psychologists were emphasizing individual creative processes, Cummings (1965) focused on the press/environment of creativity. Trying to explain a creative organization's processes, Cummings and O'Connell (1978) developed their Systematic Model of Organizational Innovation by analyzing the characteristics of creative organizations from a systems view. They suggested the five stages of innovation processes: "(1) search for the source of the problem, (2) alternative generation, (3) alternative evaluation, (4) selection and initiation of an alternative, and (5) acceptance and routinization" (p. 33). Also, they categorized the two major forces to initiate the process of innovation: gaps between goals and performance, and monitoring behavior for opportunities from the environment.

The 1970s to 1990s

Kirton (1976) placed creative people on the spectrum from *Adaptors* to *Innovators*. To conceptualize creative people, his framework takes into account interactions between organizational context and individual traits. *Adaptors*, for example, display behavioral characteristics of conformity, collaboration, discipline, efficiency, prudence, and stability; on the other hand, *Innovators* are more likely to challenge existing rules, take control in an unstructured situation, act insensitively to others, and generate shocking and seemingly impractical ideas. Interestingly, he found that more females were closer to the *Adaptors* type than males, and later another researcher also supported this gender difference (Foxall, 1992). This gender difference was also found in the educational setting. Male students' creativity was more accurately assessed by teachers who see creativity as innovative; female students' creativity was more accurately assessed by teachers who see creativity as adaptive (Gralewski and Karwowski, 2018).

Gruber's (1988) Evolving Systems Approach focused on developmental and incremental characteristics of the creative process, with the underlying logic that even Big-C innovators repeated the same creative task for improvement throughout their life. So, a creative process would be similar to a personal constructive learning experience. However, his model also emphasized the dynamics of a creative individual's social network (e.g., collaboration, available knowledge, and chance) as well as the creator's purpose, curiosity, emotion, and insight. Thus, from Gruber's perspective, Van Gogh's work can be interpreted as a combination of the artist's deliberate practice, passion, meaning, and planned behavior rather than an inspirational moment arising from his purported madness (Brower, 2003).

Csikszentmihalyi's Systems Model (1988) explicitly chose three factors to answer the question, "Where is creativity?" He thought that creativity occurs as a result of dynamic interactions among *field* ("a set of social institutions"), *domain* (a stable context that preserves and selects ideas), and *individual* (an agent). He pointed to the Renaissance as a time when a community's wealth

supported talented artists to be innovative. This Systems Model, although decades old, is flexible enough that it can explain current fast-changing technology and communication domains, such as YouTube (Henriksen and Hoelting, 2016).

Amabile (1982, 1983) and Amabile and Pratt (2016) suggested a componential theory of creativity. This sociocultural framework and its measuring method, the consensual assessment technique, are based on intertwined components of creativity at both the individual and organizational levels: domain-relevant skills, creative-processing skills, and intrinsic motivation. In individual/group creativity, domain-relevant skills include knowledge, technical skills, and specific talents, and creative-processing skills contain risk-taking attitudes and ambiguity tolerance. Her conception of intrinsic motivation is a core fuel of creative behavior. Unlike extrinsic motivation (e.g., incentive, grades, and reputation), people with high intrinsic motivation can be driven by internal reasons, such as fun, pleasure, satisfaction, and a sense of connection to the world or others (Ryan and Deci, 2000). This internal force for creativity was also elaborated by the concept of Flow referring to the states of transformative joy without awareness of oneself and external situations (Csikszentmihalyi, 1990). On the other hand, organizational innovation consists of interrelated components of management skills, resources, and motivation to innovate (Amabile and Pratt, 2016).

John-Steiner (1992) argued that the creativity research in the 50s, 60s, and 70s was mostly about creative individuals removed from social context. She supported the importance of social interactions in creativity, influenced by the Russian theorist Vygotsky, whose writings had been recently discovered by the West. Vygotsky's sociocultural learning theory viewed learning as a dynamic result from internal cognitive processes and interpersonal interactions (e.g., mentorship and apprenticeship) in a culture and language where an individual's cognition is situated (McCormick and Scherer, 2018). In particular, John-Steiner focused on the creative process arising from the tension between independent personal growth and growth dependent on others, such as disciplinary-interdisciplinary and expert-novice relationships.

The Investment Theory of Creativity (Sternberg and Lubart, 1991) borrowed a metaphor of the financial market ("Buy low and sell high") to explain creative people's "defying the crowd" attitudes and characteristics. The theory argued for six different constructs that need to align for such creativity to occur: intrinsic motivation, optimal levels of intelligence and domain-knowledge, an open personality, a self-directed thinking style, and opportunities from a creativity-nurturing environment. In their model, creative people can see undervalued ideas, and they are capable of persuading the market to appreciate the ideas. Creators then "sell" the ideas at a high price before pursuing new ideas. This view can explain the relativistic nature of one of the pillars of creativity construct, originality. As soon as a majority of people agree that an idea is creative, the idea may lose its newness. For example, Monet's painting technique would not be considered as original and creative now since his impressionism is not new anymore. Recently, Sternberg's (2018) Triangular Theory of Creativity (defying the crowd, oneself, and Zeitgeist) expanded the Investment Model.

Woodman et al. (1993) developed a Multilevel Model of Organizational Creativity that focused on interactions among characteristics of a person, a group (as a mediator between an individual and an organization) and an organization. These three creative units are seen as mutually influencing creative behavior and the creative environment for successful organizational creativity.

The Propulsion Model of Creativity (Sternberg, 1999; Sternberg et al., 2004) explains different impact levels of creative contributions in a field. Its authors suggested a taxonomy with eight categories: 1) Replication, 2) Redefinition, 3) Forward incrementation, 4) Advance forward incrementation, 5) Redirection, 6) Reconstruction/redirection, 7) Reinitiation, and 8) Integration. The first four types of creative contribution sustain and move forward a field, whereas the last four take the field in new directions.

The following uses the field of jazz as an example, jazz musicians who cover a song and try to sound like the original artist contribute to sustaining the domain (Replication). Improvisation is a core distinguishable factor of jazz. Louis Armstrong redefined improvising as an independent status beyond the traditional composition and performance of music (Redefinition). Swing jazz was a modern evolution from more original style jazz due in part to its danceable quality (Forward incrementation). This type of creative contributions is most common. Miles Davis embraced electronic instruments and non-jazz components regardless of controversy, influencing future jazz generations (Advance forward incrementation). Cool jazz deliberates soothing and comfortable sentiment beyond fast Bebop and danceable Swing (Redirection); Funk re-focused on popular and danceable beats rather than mellow or dizzy melodies (Reconstruction); Bebop was separated from Swing, gaining an independent power as an art from itself apart from Swing's entertaining danceable component (Reinitiation); Bossa nova is a result of samba and jazz, but jazz itself is a synthesis of African music and European instruments/format (Integration).

The Geneplore (Generate-Explore) model (Finke et al., 1992) is consistent with Guilford's cognitive framework due to similarities between the two broad creative cognition stages (idea generation and evaluation). However, the Geneplore model is more elaborate with details of mental visualization skills, imagination, and applications in different types of creative expressions (e.g., creative inventions and concepts). It consists of five sub-steps: Generative Process, Preinventive Structure, Preinventive Properties, Exploratory Processes, and Product Constraints.

The 2000s

Unsworth's (2001) Matrix Model is more focused on industrial and organizational productive creativity. The model is divided into four categories of creativity based on two central questions about interactions between individuals and organizations: "What makes people engage in creative and innovative activities?" and "What initiates people's creativity?" The first question can be answered with the help of a motivational continuum (external vs. internal) and the second question with a problem-type continuum (closed vs. open). Open problems include proactive problem-searching. Closed problems, however, are already perceived, shared, and

presented in a group. Thus, *Responsive* creativity (external $\times$ closed) refers to solving a specifically given problem for an external reward. *Expected* creativity (external $\times$ open) includes a problem-discovery process for external reasons. *Contributory* creativity (internal $\times$ closed) is voluntary creativity on a specific problem. *Proactive* creativity (internal $\times$ open) includes intrinsically motivated creative actions on a discovered problem.

Piirto's Pyramid model (1995) includes many possible factors of talent development for gifted education. Later, she developed the Seven I's model that explains the seven different creative processes: Inspiration, Imagery, Imagination, Intuition, Insight, Incubation, and Improvisation (2004). In general educational settings, Treffinger et al. (2002) developed the COCO model that includes four *interdependent* constructs: Characteristics (person), Operations (process), Context (press), and Outcomes (product). They also developed a systematic assessment tool for classroom teachers to foster their students' creativity based on the students' creativity developmental stages: not yet evident, emerging, expressing, and excelling.

Florida's idea of the Creative Class (2012, 2014) goes beyond the scope of individual or organizational psychology. He argues that a community is similar to an agent that acts in a constantly changing dynamics. Creative communities (or groups) have common tendencies: high-levels of technology, tolerance to differences, and many talented people. Aspects from this community view can be translated into respective evidence-supported creative factors from individuals: *technology* into resource affordances (Karwowski and Lebuda, 2013), *tolerance* into the openness aspect of personality (Kaufman et al., 2016), and *talented* people into both cognitive ability (Plucker and Esping, 2015) and domain knowledge (Batey et al., 2010).

The Amusement Park Theoretical (APT) model (Baer and Kaufman, 2005) aimed to explain the nature of both domain-specific and domain-general creativity. This metaphoric model is hierarchical including (1) general initial requirements (e.g., intelligence or motivation—an equivalent to an admission ticket and transportation), (2) thematic areas (e.g., the arts or science—such as a zoo and cartoon character park), (3) domains (e.g., journalism in writing—a specific cartoon character park, such as Disneyland), and (4) micro-domains (e.g., newspaper journalism—a specific attraction or ride).

Galenson's *experimental creators* and *conceptual creators* (2005) are two different types of creativity that are both valuable in society. Experimental creators tend to evolutionarily create based on the trial and error principle. Conceptual creators tend to more discreetly create things beyond the current paradigm. For example, Cézanne's work was a result of his perfecting and experimental processes, but Picasso started with the breakthrough conceptual idea, Cubism. These two types of creativity can be seen as comparable to the concepts of Kirton's (1976) Adaptor vs. Innovator model as discussed above, continuous and discontinuous creativity in Goswami's (1988) quantum theory perspective, and Gilson and Madjar's (2011) Incremental and Radical creativity within an organization.

The Four C's Model proposes a developmental trajectory of an individual's creative development. An expansion of traditional concepts of little-c (i.e., everyday creativity) and Big-C (i.e., genius creativity) concepts (first articulated by Csikszentmihalyi, 1988), Beghetto and Kaufman (2007) first added *mini-c*, creativity that is personally meaningful and new (e.g., self-awareness). Subsequently, Kaufman and Beghetto (2009) added another creative level, *Pro-c*, expert-level creativity, between little-c and Big-C. Pro-c occurs when an individual begins to contribute to a field and can extend throughout that creator's life. The transition to Big-C typically happens after a creator's death.

Runco (2007), as an advocate of creative potential, suggested two separate hierarchies for creativity research: *creative potential* and *creative performance*. Creative potential includes Person, Process, and Press, whereas creative performance consists of Products, Persuasion, and interactions between a person and environment.

The 2010s to Current

Contemporary creative models are generally more diverse and complex, taking into consideration the arts, sociohistorical views, groups, benevolent intention, brain, knowledge, emotions, and many other concepts.

Glăveanu views creativity as an inseparable phenomenon from historical and cultural contexts. His creativity paradigms (2010) and A Five A's Model (2013) are grounded in a view of dynamic individual-society interactions. The first model explains modern creativity in different time-periods of paradigms: the He-paradigm (e.g., solitary genius view, especially before the 1950s), the I-paradigm (e.g., cognitive and personality approaches of the 60s and onwards), and the We-paradigm (e.g., creative collaboration and co-creation as emphasized from the 80s onwards).

The Five A's Model is Glăveanu's sociocultural adaptation of the 60's Four P's Model. With this lens, *Person* turns into *Actors*, *Process* into *Actions*, *Product* into *Artifacts*, and *Press* into *Affordances* (material and personal resources) and *Audiences* (both those who offer mentorship and feedback as well as those people who will interact with the final product). All components are seen as interdependent.

The Reciprocal Model (Forgeard and Mecklenburg, 2013) added another dimension of creative force, self-oriented (self-serving)/other-oriented (prosocial) beneficiaries from social perspectives beyond intrinsic and extrinsic motivations. Thus, the four categories emerged based on the two dimensions: *Growth* (intrinsic motivation $\times$ self-oriented benefit), *Gain* (extrinsic motivation $\times$ self-oriented benefit), *Guidance* (intrinsic motivation $\times$ other-oriented benefit), and *Giving* (extrinsic motivation $\times$ other-oriented benefit).

The Motivated Information Processing in Groups Model originated from group decision-making (De Dreu et al., 2008), and was expanded to creativity and innovation (De Dreu et al., 2011). The focus is on the function of group members' levels of prosocial motivation and epistemic motivation in organizational innovation. Epistemic motivation refers to a willingness to deliberately and

thoroughly understand the world beyond apparently given information. Thus, when members show higher prosocial and epistemic motivation, group creativity may be more likely to occur.

Batey's (2012) New Heuristic framework is aimed to holistically measure creativity by integrating current creative assessment models and tools. It has three dimensions: creative levels, facet, and measurement. Creative levels include the four units of creative action: individual, team, the organization, and the culture. The creative facet follows the Four P's Model: personal trait, process, product, and press. Finally, measurement is divided into three categories: objective, self-rating, and other-ratings (e.g., teachers rating their students).

In Tinio's (2013) Mirror Model, a consumer of a creative artwork follows the reverse-process of the artist's creative process. In essence, an artist's completed product is the last stage of the creative process, but the product is the first stage of aesthetic experiences for an audience. This model highlighted the pivotal role of the audience in the interactive process of creativity and aesthetics.

Conclusion

This entry used a chronological approach to show how creativity theories have evolved and developed over time. It is important to note that a single model cannot explain a multi-faceted concept like creativity. It would be similar to how linear historical materialism, proposed by Marx and applied to many European countries, would be of little use in explaining India's history, which is rooted in a non-linear concept of time (Saha, 1990). Comparably, a timeline chronicling the Antiquity-Middle Ages-Renaissance periods, where the role of religious power was vital, would not apply to Korea's last dynasty, which has survived without a national religion for about 500 years. Similarly, China's history could fit in through the framework of a series of dynasties, rather than competing feudal lords, since China was centralized about 2500 years ago. Just as no approach works for all countries, so too is each model limited by its context, approach, and the theorist's perspective.

The word "contemporary" may carry the impression of complexity, or even chaos or cutting-edge, when you think about contemporary arts or music. Similarly, contemporary creative models may seem haphazard without a universal principal or assessment tool. However, this state of affairs can also be considered healthy since knowledge gained from empirical studies can always be replaced by more accurate results, and the mechanisms of the human mind are impossible to summarize in a single model.

Although many contemporary theories try to explain observable creativity, human creativity is not all about scientific or artistic progress based on creative or innovative achievement. Human creativity, we believe, is also pivotal for people to harmoniously get along with nature, others, and ourselves (see Glăveanu and Sierra, 2015).

Finally, human creativity needs to recognize all the different types of being creative specific for a diversity of human beings, such as a 12-year-old Native American girl living in Alaska, a five-year-old Muslim boy in Israel, a Christian family in Syria, and a North Korean defector, and European expatriates living in South East Asia. Thus, the hope for the future is to see more inclusive creative models that honor this diversity and value its implications.

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Creativity Training[☆]

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Glossary

Content Specific material presented in instruction.

Domain The field or area from which exercises or instructional content are drawn.

Group Comparison Comparing trained and untrained groups.

Magnitude of Effects Amount of change in outcome measure as a result of instruction.

Pre-Post Compare participant performance before and after instruction.

Processes Operations involved in creative thinking.

Strategies Actions taken during execution of creative thinking processes.

Training

Creativity, defined as the production of original, high quality, and elegant solutions to novel, complex, and ill-defined, or poorly structured, problems, is the basis for progress in the world. Creative problem-solving underlies the internet, synthetic fabrics, and micro-lending—just to mention a few innovations. The value of these innovations led firms (both for profit and non-profit), the educational system, and societies, in general, to search for the interventions likely to encourage creative problem-solving—interventions such as incentives, work design, and supervisory practices.

One of the most common interventions used to encourage creative problem-solving is education, or training intended to enhance the skills, capacities, or attitudes held to contribute to creative thought. Indeed, recent evidence pointing to declines in children, and young adults', creative thinking abilities has led to a new press for more effective educational programs intended to develop creative thinking skills. Moreover, the value of sustained innovation to firm survival has led many firms to institute creative training programs for occupations such as engineering and marketing.

This entry will examine the nature and the effectiveness of creativity training. The beginning will provide details about the objectives of creativity training programs and the methods used in appraising their effectiveness. Next the content of creativity training programs that have proved especially effective in enhancing creative problem-solving skills will be described. Finally, the generality of these conclusions across institutional settings and populations will be considered.

Objectives

At first glance, it might appear the objectives of creativity training programs are straightforward—to improve creativity. It has long been recognized, however, that creativity is a highly complex phenomenon. Thus, some creativity training programs, such as the instructional program developed by Parnes (1967), seek to develop peoples' ability for divergent thinking or the capacity to generate multiple ideas. Other programs, such as the program developed by Onarheim and Friis-Olivarius (2013), seek to develop peoples' capacities, or underlying capabilities, for solving creative problems or to provide instruction that will improve peoples' attitudes towards, or beliefs about, their competence for creative work—an example may be found in Davis and Bull (1978).

[☆] *Change History:* October 2019. Michael Mumford updated the text throughout the article.

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Not only do creativity training programs differ with respect to their basic goals, they also differ with respect to their specificity in regard to the creative performance of interest. Some programs, especially educational programs for K through 12 students, seek to improve creative thinking across a wide variety of tasks. Other programs have a narrower focus, seeking to improve creative thinking in a specific task domain. In fact, Baer (2012) argued these more narrowly focused, or domain specific, instructional programs may prove especially effective.

To complicate matters further, the objectives of training vary with respect to the specific cognitive capabilities the program is seeking to develop. Mumford et al. (2012) pointed out that creative thought involves multiple capabilities—problem finding, information gathering, concept selection, conceptual combination, idea generation, idea evaluation, implementation planning, and solution monitoring. An instructional program that seeks to develop problem finding skills has very different objectives, and very different instructional methods, than a program which seeks to improve conceptual combination or focused on idea evaluation.

In addition to goals, domain, and specificity, the objectives of training programs must take into account yet another consideration—exactly who are the people to be trained? The instruction required for eighth graders is clearly quite different than for experienced engineers. Moreover, different target populations (i.e., different groups of people) have different personalities, beliefs, and self-concepts, all of which act to influence how one might go about providing creativity training.

In this regard, one key consideration must be taken into account. The populations to be given creativity training differ markedly in their expertise, or knowledge, with respect to a particular domain of performance. As Scott et al. (2005) showed, the nature of the knowledge that people have, and the way this knowledge is structured or organized (i.e., peoples' mental models), has a significant impact on both how creativity training should be developed and the methods to be used in appraising the effectiveness of this training.

Evaluation

Sometimes training works, and sometimes it does not. Ambiguity with respect to the effectiveness of training points to another key consideration. The effectiveness of creativity training programs must be evaluated—how much change in creativity is observed as a result of instruction? In fact, the measures used to appraise the effectiveness of creativity training should not only be reliable and valid measures, they should be measures tied to the objectives of training. Thus, a program focused on improving idea generation should use a domain appropriate measure of divergent thinking. A program focused on improving creative problem-solving should be evaluated using a measure of performance—for example, judges' appraisals of solution quality and originality on a set of relevant creative problems.

The next issue to arise in evaluating the effectiveness of training pertains to the design used to appraise change as a result of training. Broadly speaking, there are two basic designs that might be employed in appraising change in creativity as a result of training. First, one might compare groups who did, and did not, receive the training. Note, this simple design can be made more complex by using groups who receive placebo training (i.e., training irrelevant to creativity), or different forms of instruction. Second, one can use one group of trainees where the measure(s) of creative outcomes are administered prior to instruction, and, again, after instruction. This pre-post design assesses the effectiveness of instruction by looking at changes in performance on these outcome measures. Again, this simple design may be extended to incorporate considerations such as the development of parallel forms of pre-post measures or appraising the maintenance of training effects over time by administering the outcome measure at varying points in time (e.g., three and six months) following instruction.

In evaluating creativity training programs, as is the case with any other training program, it is generally desirable to consider multiple relevant outcomes. For example, if divergent thinking measures are used, it is desirable to appraise multiple aspects of divergent thinking such as the number of ideas (fluency), the range of ideas (flexibility), and the originality of ideas (novelty). Not only should multiple measures be employed in evaluating the effectiveness of instruction, the transfer of the effects of instruction should also be assessed. For example, does the effects of creativity instruction for engineers' result in more patents, or invention disclosures, when the engineers go back to their jobs?

In addition to examining multiple outcomes and transfer, or generalization, of training effects to real-world settings, another point should be kept in mind when evaluating the effects of instruction. Viable evaluation of creativity training programs requires the use of control measures. For example, a program intended to improve creative problem-solving skills might not have resulted in changes in problem-solving skills per se; instead it might have increased motivation to solve creative problems. Such effects can be ruled out as competing explanations for the effects of instruction, but only if appropriate controls are employed. In some cases, controls may be taken into account through the use of additional measures intended to assess the specific variables of concern. In other cases, additional groups will need to be included in the study designs to allow the unique effects of the instructional intervention to be isolated.

Content

Many creativity training programs have been developed and evaluated using very different methods. For example, Feldhusen (1983), and his colleagues, developed a set of audio-taped lessons for enhancing divergent thinking. These short, fifteen-minute instructional sessions present a key principle for enhancing fluency, flexibility, originality, and elaboration followed by illustrations of this principle. Subsequently, students work through a set of exercises intended to illustrate, and provide practice, in the application of these principles.

Another instructional system was developed by Parnes and Noller (1972). This program focuses on improving key creative problem-solving processes such as problem finding, information finding, idea finding, solution finding, and acceptance finding. Instruction is delivered through a lecture and discussion framework where the nature of this model is described along with its implications for creative work. Subsequently, key processes are described that provide strategies for removing blocks to creativity and techniques for effective process execution. Lecture and discussion on a given topic are followed by exercises intended to illustrate key points and provide practice in applying techniques that improve application of these problem-solving processes.

Another instructional program focused on conceptual combination, a key creative thinking process, was developed by Warren and Davis (1969). In this program, participants were instructed how to analyze key features of a problem. Instruction was then provided as to ways people might combine and reorganize concepts, or features, of the problem (e.g., change shapes, re-arrange parts, add or subtract something). In addition, the use of these techniques in creative problem-solving was demonstrated.

Clearly, these programs differ in key objectives, instructional procedures, level of specificity, and evaluation criteria. In fact, over the years, a variety of different course content has been formulated for creativity training. Recognition of this point led Scott et al. (2004a) to conduct a study intended to identify the different types of content used in creativity training programs.

This study began with a review of the applicable literature to identify all creativity training programs proposed over the years. Ultimately, some one hundred and fifty extant training programs were identified. A panel of three judges, all doctoral students with an interest in creativity training, were asked to review the description of the training programs provided. They were asked to rate each program with respect to creative thinking skills stressed (e.g., problem definition, conceptual combination, idea generation), instructional techniques used (e.g., divergent thinking, convergent thinking, ideation, brainstorming, metaphors), media used in instruction (e.g., lecture, videos, social modeling, cases) and the type of performance exercises used (e.g., classroom exercises, team exercises, domain-based performance exercises, imaginative exercises). Judges showed good agreement in evaluating training courses with respect to these attributes. In addition, judges were asked to evaluate characteristics of the target population (e.g., younger vs. older trainees, gifted vs. not gifted students) and instructional parameters (e.g., course length, amount of practice, depth of instructional manual) to provide a set of external reference measures. The judges' ratings of each course attribute were used to form a profile, or a description, of the course. Subsequently, a cluster analysis was conducted to identify the general types of training used to develop creativity. In addition, these types (i.e., groups of similar courses) were described with respect to target populations and instructional parameters. Each program type was described using mean differences from other courses above, or below, a half a standard deviation.

It was found that eleven different types of courses were used in creativity training: 1) analogy training, 2) open idea production training, 3) interactive idea production training, 4) creative process training, 5) imagery training, 6) computer-based production training, 7) structured idea production training, 8) analytical training, 9) critical/creative thinking training, 10) situated idea production training, and 11) conceptual combination training. Figure one provides a summary description of each type of training on the course description measures and the references measures. (Table 1)

The types most frequently used were found to be situated idea production training, structured idea production training, and imagery training. Other instructional techniques such as critical/creative thinking training and open idea production training were used less frequently. Of course, the frequency with which people used a given type of training approach has little to say about the effectiveness of this training approach. The effectiveness of creativity training was examined in another study by Scott et al. (2004b).

Effective Content

In the second Scott et al. (2004b) study, evaluation data bearing on the effectiveness of these creativity training programs was examined in a meta-analysis. The study examined not only the overall impact of creativity training, but also the key characteristics of courses that resulted in more, or less, effective creativity training. Effectiveness was assessed with respect to the four outcome measures most commonly used in studies of creativity training 1) performance on divergent thinking measures, 2) performance on creative problem-solving tasks, 3) real-world creative performance, and 4) attitudes toward creativity. Cohen's d was used to assess effect size where a d below 0.40 indicates a weak effect, a d between 0.40 and 0.60 indicates a moderate effect, and a d above 0.60 indicates a large effect. Across all outcome measures for all instructional programs the average d obtained was 0.68. The strongest effects were obtained when the outcome measures examined divergent thinking ($d = 0.75$) and creative problem solving ($d = 0.84$). The weakest effects were obtained for real-world performance ($d = 0.35$) and attitudes ($d = 0.24$). Thus, creativity training is, apparently, valuable as a technique for improving creativity. Indeed, this finding has been confirmed in another, independent, study.

The next set of questions examined in this study considered the key attributes of more, or less, successful creativity training courses. Here judges' ratings of course attributes were correlated with obtained effect sizes obtained for the various outcome measures. It was found that training programs stressing problem identification, idea generation, implementation planning, concept selection, and conceptual combination were strongly, positively, related to overall program effectiveness ($r = 0.49$). Moreover, instructional programs stressing these processes resulted in much better creative problem-solving as well as better real-world performance and attitudes toward creativity.

Another key characteristic of effective creativity training programs is that they provide practice, substantial practice, in solving domain-relevant creative problems. The effect sizes obtained in creativity training programs were found to be strongly, positively,

Table 1 Summary of cluster analysis results

<i>Types</i>	<i>Mean differences on variables</i>
1) Analogy training	Cluster: Conceptual combination, feature listing, feature comparisons, analogies, lecture, class exercises, case-based exercises, written exercises Reference: Large sample, elementary school students, problem-solving criteria, high depth, high difficulty, substantial practice, limited feedback, long course
2) Open idea production training	Cluster: Idea generation, divergent thinking, ideation, elaboration, brainstorming, expressive activities, programmed instruction, discussion, class exercises, written exercises, imaginative exercises Reference: Large sample size, middle school students, long course, low depth, low difficulty, non-domain specific, non-realistic exercises, divergent thinking criteria, training focused on divergent thinking criteria
3) Interactive idea production training	Cluster: Problem identification, idea generation, conceptual combination, divergent thinking, ideation, elaboration analogies, brainstorming, lecture, discussion, class exercises, cooperative learning, group exercises Reference: Small sample, high school and college students, control group, divergent thinking criteria, short course, low depth, low difficulty, realistic exercises, peer coaching, interaction in class, holistic learning
4) Creative process training	Cluster: Problem identification, information gathering, concept selection, conceptual combination, idea generation, idea evaluation, implementation planning, monitoring, divergent thinking, convergent thinking, analogies, brainstorming, lecture, discussion, case-based exercises, self-paced exercises Reference: Small sample, college students, problem-solving criteria, lengthy training, substantial practice, realistic practice exercises, high depth, high difficulty, substantial feedback, interaction in class
5) Imagery training	Cluster: Imagery, expressive activities, discussion, class exercises, imaginative exercises, group exercises Reference: Large sample, middle school students, originality, and divergent thinking criteria, short course, low depth, low difficulty, non-realistic exercises, limited practice, feedback, and instructor encouragement
6) Computer Based production training	Cluster: Idea generation, divergent thinking, meta-cognition, elaboration, lecture, computer assisted instruction, programmer instruction, social modeling, class exercises, computed exercises, group exercises Reference: Small sample, elementary school students, control group, divergent thinking criteria, substantial practice, long course, little feedback, interaction in training
7) Structured idea production training	Cluster: Idea generation, divergent thinking, ideation, convergent thinking, feature comparisons, feature listing, lecture, discussion, class exercises Reference: High school students, occupational settings, gifted students, divergent thinking criteria, problem-solving criteria, high depth, substantial practice, realistic practice exercises, feedback in practice
8) Analytical training	Cluster: Problem finding, information gathering, idea generation, idea evaluation, solution monitoring, strengths and weaknesses identification, programmed instruction, class exercises, self-paced exercises, written exercises Reference: Large sample, elementary school students, divergent thinking criteria, problem-solving criteria, high depth, high difficulty, low realism, feedback in practice, substantial practice, part learning, no peer coaching
9) Critical/Creative thinking training	Cluster: Problem finding, idea generation, idea evaluation, selection monitoring, critical thinking, meta-cognition, elaboration, brainstorming, lecture, discussion, role modeling, cooperative learning, case-based learning, imaginative exercises, class exercises, group exercises Reference: Small sample, short course, middle school students, divergent thinking criteria, problem-solving criteria, high depth, high difficulty, realistic, substantial practice, interactive exercises, peer coaching, limited feedback, training focused on criteria
10) Situated idea production training	Cluster: Idea generation, divergent thinking, ideation, elaboration, brainstorming, audio-visual, programmed instruction, case-based reasoning, class exercises, self-paced exercises, written exercises Reference: Large sample, elementary school students, divergent thinking criteria, short course, some practice, realistic practice, little feedback
11) Conceptual combination training	Cluster: Conceptual combination, convergent thinking, feature comparisons, analogies, metaphors, lecture, individual coaching, social role modeling, class exercise, imaginative exercise Reference: Short course, gifted students, elementary school students, small sample, limited practice, not realistic practice, high depth, high difficulty, substantial feedback, holistic learning, massed practice

related to providing realistic practice exercises, providing more practice time, having depth in practice material, presenting different material, and giving viable feedback with respect to viable performance models. Thus, effective creativity training programs apparently provide substantial domain-relevant practice in executing key creative thinking processes. As might be expected, effective creativity training programs are likely to employ both individual and group performance exercises, often using case-based and cooperative learning techniques, along with modeling and viable coaching as people work through relevant practice exercises.

When providing feedback, however, some instructional techniques appear more effective than others. Encouraging convergent thinking and critical thinking, along with constraint analysis, was strongly, positively, related to the effect sizes obtained in creativity training programs. In other words, instruction that gets people to focus on providing viable solutions, and constrained solutions, to the problems at hand is beneficial. In contrast, more open instruction, and instruction encouraging the use of imagery, metaphors, and self-expression, typically undermined the effectiveness of creativity training. Indeed, these findings were consistent with earlier findings indicating that imagery based instructional programs, despite their wide-spread use, are the least effective way to provide creativity training.

Strategy Training

Scott et al.'s (2004a, 2004b) findings point to a straight-forward conclusion: effective creativity training seeks to develop requisite creative thinking processes through extensive domain-specific practice. This observation, however, broaches another question. How should one go about encouraging effective execution of requisite creative thinking processes? One answer is to provide people with more effective strategies for working through, or executing, each process.

A series of studies by Mumford and his colleagues (e.g., Mumford et al., 2012) began to identify the key strategies people need to use in executing the various processes contributing to creative thought. For example, in problem definition, people should define problems with respect to procedures and constraints, not goals. In information gathering, people should search for key facts and anomalies bearing on these facts. In concept, or case selection, they should search for a diverse set of concepts, or multiple cases, that might allow them to organize facts vis-à-vis anomalies. In conceptual combination, they should search for shared features of relevant concepts and elaborate extensively on emergent new features. When generating ideas, they should extensively explore potential applications of these new features taking into account constraints, whereas, in idea evaluation, they should seek to compensate for potential deficiencies in ideas prior to selecting workable ideas. In implementation planning, they should forecast extensively taking into account both constraints and resources, while, in adaptive monitoring, they should identify key diagnostics constantly seeking feedback on performance.

The value of training in these strategies was demonstrated in a study by Scott et al. (2005). In this study, participants were asked to assume the role of a principal of a new experimental secondary school and formulate a plan for leading this school. Judges appraised plans for quality and originality. Prior to starting work on this problem, participants were presented with a number of relevant concepts and given instruction to search for shared features of these concepts and elaborate on the implications of the shared features that were identified. This instruction resulted in creative problem solutions of higher quality and originality.

In another study along these lines, Osburn and Mumford (2006) asked participants to formulate a plan for leading an experimental secondary school where judges were asked to appraise the quality and originality of curriculum plans. Prior to starting work on these plans, participants completed a set of self-paced instructional modules focused on strategies that might contribute to effective implementation planning such as identification of key causes, actions under personal control, interdependencies in actions, and identification of downstream consequences. In training people to use each strategy the strategy was defined, its application in creative problem-solving was illustrated, practice in using the strategy was provided on a set of semi-structured problems, and practice was provided on more open-ended problems. Findings indicated that people who received this strategy training produced more creative problem solutions than those who did not receive this training.

Clearly, instruction in strategies contributing to effective execution of various creative thinking processes does seem to contribute to viable creativity training. In this regard, however, it should be noted that while some strategies are specific to a certain process, other strategies appear to contribute to effective execution of multiple processes. Mumford et al. (2012) argued that forecasting, casual analysis, and constraint analysis all might contribute to effective execution of multiple creative thinking processes. In keeping with this observation McIntosh et al. (2020) found that more extensive forecasting contributes to both better idea evaluation and better idea generation.

What should be recognized here, however, is that instruction in viable cross-process strategies also appears to contribute to more effective creativity training. Hester et al. (2012) and Marcy and Mumford (2007) provided, or did not provide, participants with strategies for thinking about, or working with, causes in creative problem-solving—for example, thinking about causes that have direct effects, thinking about causes you can control, and thinking about causes that work synergistically. Following training in the Marcy and Mumford (2007) study, participants were asked to solve a series of social innovation problems, while in the Hester et al. (2012) study, they were asked to provide solutions to a creative marketing problem—an advertising campaign for a new high energy root beer. In both studies judges appraised the quality, originality, and elegance of creative problem solutions. And, in both studies, it was found that providing training in causal analysis strategies contributed to the production of more original, higher quality, and more elegant solutions. Other studies have provided evidence for the value of training cross-process strategies bearing on constraint analysis and error analysis.

Taken as a whole, these studies indicate that training people in thinking strategies, both process specific and cross-process strategies, contributes to effective creativity training. In this regard, however, three key considerations should be taken into account when developing such programs. First, strategy training is unlikely to have much value if people lack the basic expertise needed to work through creative problems arising in a given domain. Secondly, some creative thinking processes are more important to performance in some domains than others—thus, in the social sciences conceptual combination is especially important whereas in health sciences problem definition is more important. Accordingly, instruction is most likely to prove effective if it focuses on strategies used in executing critical creative thinking processes. Scott et al. (2005) showed different strategies are used in creative thinking when different types of knowledge (e.g., case-based or conceptual) are employed. Thus, strategy training should take into account the types of knowledge and level of expertise in the population to be trained.

Conclusions

The foregoing observations are noteworthy because they imply the development of effective creativity training programs will require a careful, and thorough, analysis of the type of creative problems people are presented with a domain, the processes critical to solving these problems, and the strategies that allow people to execute these processes. Assuming one has done their “homework” in this regard, and participants have the requisite domain expertise, then it appears that training will have real value as a vehicle for enhancing creative problem-solving.

In fact, the evidence examined in the present effort indicates that if such training provides people with the strategies needed to execute key creative thinking processes and provides extensive practice in applying these processes, and strategies, in solving domain-relevant problems, training may prove to be a potentially powerful technique for enhancing creative performance. Of course, this observation implies creativity training must be disciplined, and focused on performance within a domain, if it is to prove effective. Although such disciplined and focused training may take time to develop, the time required to develop viable training programs, however, does seem easily justified given the strong effects viable training programs have been found to have on divergent thinking, creative problem-solving, creative performance, and attitudes toward creativity.

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Criterion Problem

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Introduction

The criterion problem is the challenge of identifying who is creative and what aspect of a product identifies it as being creative (Shapiro, 1970). The criterion problem has lasted over seven decades and is still one of the most challenging issues in creativity research. The criterion of creativity is defined as what should be considered to determine the creativity of a person or product. Although the criterion is often led by people's insight, it should be established on rational grounds. What determines the rational grounds of creativity relies on thoroughly analyzing the characteristics of creative products and their intrinsic nature. However, it seems that there is little agreement on the rational grounds of creativity, which yields conflicts in defining what the criterion of creativity should be.

The following questions may elicit where the conflicts in the criterion problem specifically come from: What is the ultimate criterion of creativity? How are substitute criteria defined in relation to the ultimate criterion? Is creativity tangible and observable regarding outcomes such as products and persuasion? Or is it in the potential such as processes, personality, and places (i.e., environment facilitating people to be creative)? When determining creative products, can quantity of performance serve as a predictive proxy of its quality? Is self-perception of individuals' creativity equivalent to individuals' creativity recognized by their products or other people?

There is no single correct answer to these questions. Reviewing what has been studied to answer these questions may show why determining the criteria of creativity is still challenging. Thus, this chapter shows that the criteria of creativity range widely by which level of creativity is considered, whether to use quantity of performance as a predictive proxy of quality, and even who might be adequate judges of creativity. Also, challenges attributed to the criterion problem are discussed.

Ultimate Versus Substitute Criteria

Delineating the rational grounds of creativity is the key to identifying the ultimate criterion of creativity. Regarding the intrinsic nature of creative products, Ghiselin (1963) summarized four requirements for the essence of ultimate criteria, although a few more characteristics may need to be added. First, the products must be physical or spiritual things created by the agency of human which is distinct from the products of mere existence or natural production (p. 31). Human production assumes purposeful creation by humans excluding the accidental consequences of human's acts. Take an ax, for instance, as illustrated by Ghiselin (p. 35), a product constituting of stone and stick is counted as creative only when humans intended to put them together in order to embody the designs (i.e., meaning or concepts) of the mind.

Next, the products should be "intrinsically a configuration of the mind, a presentation of constellated meaning, which at the time of its appearance in the mind was new and unique (Ghiselin, 1963, p. 36)." Because the individual components of the products may have been used widely or are familiar to people, the simple aggregation of the individual components does not create any meaning. Simply speaking, the whole is greater than the sum of its parts as the unique associations among the parts make the products creative.

More importantly, the associations (i.e., products) should be created for the first time in their history, affirming their origination. The ax creator related stone to stick to embody his or her idea in a meaningful way that no one has tried before, indicating that his or her idea is the origin of an ax. Of course, the original production can be later repeated or slightly modified, but it should be merely considered reproduction.

However, some modifications may change the meaning of the products. This is illustrated in the example of the B. F. Goodrich Company slicing surgical tubing into rubber bands to be sold (Ghiselin, 1963, p. 37). If the modification produces meanings distinct from the preceding ones, it goes beyond mere reproduction and can be regarded as creative. One of the key differences between reproduction and creative products is that the modification contributes to a spiritual addition. In other words, the creative

products should add unique meanings beyond what exists by restructuring preceding ones or extending their applications. Nevertheless, Ghiselin clearly differentiated the level of creativity between initiating its creation and extending/advancing its applications; the former is defined as higher creativity, and the latter is defined as lower creativity.

The rational grounds described by Ghiselin theoretically justify what should be considered for the ultimate criterion. It is ideal to find and evaluate the ultimate criterion (the product meeting the four requirements) to assess creativity. Yet, we need to leverage the level of the criterion to obtain practicability of its use. In the mid-1950s, a group of psychologists including J. P. Guilford, Frank Barron, Benjamin Bloom, and Calvin Taylor, got together for the first time to discuss the identification of creative scientific talent. In the Criterion Committee Report from this conference, [Harmon \(1956\)](#) suggested a measure of the individuals' total creative accomplishment in their entire life as an example of the ultimate criterion. As an example of scientific creativity, several things should be carefully considered to avoid possible errors in approximating creativity of all the products that a scientist created ([Harmon, 1956](#), p. 251). The scientist of interest should be 60+ years old so that the criterion can cover his life span. All his creative accomplishments should be collected throughout his entire life. Objective evaluation tools (or systems) should be set up to rate the creativity of his accomplishments. Then, a panel of scientists should be recruited and asked to judge the creative merit of his accomplishments using the objective evaluation tools. Unless a panel of judges is involved in the evaluation, painstaking historiometric assessment (analyzing a retrospective report of historic figures' creative accomplishment or productivity throughout their life span using objective rules) may be another option as [Simonton \(1990\)](#) has used in his research on geniuses and historic creators. As seen in the example, assessing the ultimate criterion takes enormous cost and time which is not quite feasible with most products of creativity.

This challenge encourages the development of substitute criteria which are more feasible and practical. The *intermediate criterion* is what can be measured at the earlier stage of an individual's life and is expected to be highly correlated with the ultimate criterion ([Harmon, 1956](#), p. 252). For instance, the intermediate criterion could be evaluating individual early-career scientists' creative accomplishments collected until their early 30s such as papers, patents, and membership/officership in scientific organizations, participation in creative activities, or amount of training required for the accomplishments. Instruments, such as [Holland and Nichols's \(1964\)](#) Extracurricular Achievement Scale and [Hocevar's \(1979\)](#) Creative Behavior Inventory in various domains, measure intermediate products.

Still, the intermediate criterion might not be the most cost-effective way of evaluating creativity. To this end, sample behaviors demonstrating the typical mode of functioning as a scientist may be counted as approximate criteria, assuming that those behaviors are highly correlated with the ultimate criterion. For instance, a person is given a problem to solve, which is an essential task for being a scientist, then judged on how he or she solves it ([Harmon, 1956](#), p.254). In the divergent-thinking tests, creative problem-solving tests, and tasks of formulating scientific hypothesis, products serve as *immediate criteria*.

Thus, depending on the level of the criterion, products can be immediate, intermediate, or ultimate creative products. The criterion problem still remains, in part because there is a need to decide which level can be used for the criterion. Additionally, depending on which time period is used, the criterion may change.

Product Versus Potential as the Criterion

Tangible and observable products are usually favored in defining creativity over creative potential which is yet to be covered. [Plucker et al. \(2004\)](#) reviewed 90 articles in major creativity journals and synthesized common themes emerging across the articles in defining creativity. They proposed that "creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context (p. 90)."

Key attributes of a perceptible product are observability and tangibility of produced outcomes. They suggested that observable and measurable evidence promotes scientific investigations of creativity. Products are criteria that are easily quantified and objective which provides the quantified reliable scores. It is fairly easy and straightforward to say people who won awards such as the Nobel Prize, the Academy Awards, or Golden Globe Awards are creative because of the face validity of those awards as discussed by Simonton in the Awards entry in this Encyclopedia. However, the perceptible products may not be necessary. As noted in the rational grounds of creative products ([Ghiselin, 1963](#)), the products are the material objects embodied by a group of thoughts (e.g., meaning, insights, ideas, images, esthetic realizations). In this sense, the real products of the mind are the subjective realizations of the thoughts themselves, not the objects, as they are merely assembled outcomes ([Ghiselin, 1963](#), p. 33). According to this notion, the thoughts themselves can be considered the criterion; they have yet to be embodied.

One of the probable reasons is that creative products may depend on more than just creativity. Although people have creative abilities, they might not be manifested unless they obtain the knowledge and skills necessary to produce creative outcomes and are motivated to do so. In fact, creative innovation can be carried out by experts only through extended deliberate practice. Due to these probable obstacles eliciting creative performance from potential, identifying criteria representing creative potential is worth paying attention to particularly in populations who have not had opportunities for deliberate practice. For instance, non-professionals may not yet be creative because they have not acquired specialized knowledge and skills in a domain. This may be for many reasons including lack of resources, opportunities, time, or motivation. When considering that a great deal of inequity is seen in educational resources and opportunities in children, product-based criteria discourages uncovering creative potential. Thus, the potential-based approach, identifying the criteria related to cognitive process, personality, and places, is still worthy of attention.

Take ideational behaviors as an example, [Runco et al. \(2000–2001\)](#) argued that creative performance including creative accomplishments may not be an appropriate criterion of divergent thinking (DT) tests. DT tests are often used as a tool for assessing the potential of creative thinking. In order to examine the extent to which DT tests actually assess creativity (or more accurately a component of creativity), predictive validity is usually investigated by testing correlations between the DT test scores and creative performance. Documented predictive validity of DT test scores is not as convincing as they would need to be, with correlations ranging from zero through 0.6 when counts of creative achievement are considered as the criteria ([Plucker, 1999](#); [Runco et al., 2010](#)). Thus, [Runco et al. \(2000–2001\)](#) proposed ideational behaviors as the criteria of DT which “describe actual overt behaviors (i.e., actions and activities) that clearly reflect an individual’s use of, appreciation of, and skill with ideas (p. 394).” Because the actual overt behaviors only involve ideation and do not necessarily require consequential products or performance, it is argued that ideational behaviors are the appropriate criteria of divergent thinking because that’s what these tests test—ideation. In addition, ideation is independent from external factors such as educational resources and opportunities.

Besides ideational behaviors, indicators assessing creative potential include dispositional traits, developmental experience, and the cognitive processes underlying ideation or solving problems. The measures of these indicators can also elicit the creative potential of people who have yet to fully develop it into a tangible product.

Quantity Versus Quality as the Criterion

One of the most tenable measures assessing individuals’ creativity is the Creative Activity and Accomplishment Checklist (CAAC; [Holland and Nichols, 1964](#); [Hocevar, 1979](#)) which has been widely used in empirical studies (see [Paek & Runco, 2017](#)). All activities and accomplishments listed in this measure are equally weighted and aggregated into a single index which is purported to represent an individual’s creativity in the product-based approach. The more one has experienced creative activities and acquired creative accomplishments, the higher the CAAC scores. Someone may question whether an activity and an accomplishment can be equally treated. Unless quantity and quality are regarded as equal criteria of creativity, they might need to be weighted differently.

Empirical investigations uncovered that some people might be overlooked when either quantity or quality criteria are solely used in identifying their creativity. [Paek and Runco \(2017\)](#) adapted the CAAC to children and computed two creativity scores for each child. One score represents the quantity criterion computed by counting the frequency of ordinarily creative activities. The other scores represent the quality criterion computed by counting the frequency of extraordinarily creative activities and accomplishments. Then, they identified children as highly and moderately creative using the threshold of the top 10% and 25% in each of the quantity and quality scores. Interestingly, they found that children who were identified as creative using the quantity criterion did not fully match those who were identified as creative using the quality criterion. The two criteria agree in only approximately half (33%–50%) of children. The overlap ranged from 54% through 67% among children identified as moderately creative. Given that top 10% is often used as the threshold to determine who is eligible for gifted programs in K-12 schools across many states, it is very likely that approximately half of bright students may not be identified as creative as they actually are which, in turn, inhibits them from receiving educational opportunities that they deserve.

Although this empirical finding implies that the quality criterion is noticeably distinctive from the quantity criterion, there is another perspective which may support the use of the quantity criterion as a predictive proxy of the quality criterion. The order effect is the well-known notion where the more ideas that are generated, the more likely the later ideas are original ([Mednick, 1962](#)). If people generate more ideas, they are likely to produce mundane ideas at the beginning and consequently come up with more original ideas later. Put differently, quantity scores representing the most responses may predict to what extent the responses are original as a whole. This link between quantity and quality in ideation is also empirically supported by high correlations between fluency and originality in DT tests. From this perspective, the quantity criterion can be used as a substitute for the quality criterion although they are not conceptually equivalent.

Self-evaluations Versus Objective Measures

People’s creativity can be assessed in several ways: a) Experts of the domain are invited and asked to evaluate the products that people have created, which is referred to as the consensual assessment technique. The products can be drawings, poems, stories, musical pieces, or performances such as dances and public speech. Because experts judge originality of the products, the consensual assessment technique is regarded as fairly objective. b) Another objective way is to assess their performance. People are, for instance, asked to generate responses to DT tasks, then the generated responses are scored for productivity and originality for each person. c) The third way is simply asking peers or supervisors to rate creativity based on their experiences and observations of people generating creative ideas and solving problems in creative ways.

A great deal of consensus and agreement are found across these objective measures of creativity—expert judgment, performance assessment, or peer and supervisor ratings. Yet, these objective measures aren’t used frequently in laboratory experimental research, or are restricted to research of small samples because they are time and labor intensive. This has led to an increased use of self-evaluation or self-perception of one’s creativity.

However, it is questionable whether self-evaluation is a valid criterion of creativity because of the subjectivity ingrained in self-rating. [Reiter-Palmon et al. \(2012\)](#) summarized two issues regarding the validity of self-evaluations. One is whether people

understand what (personality, attitudes, value, or creativity) they are asked to evaluate. The second is whether people accurately report or assess their creativity (or what is asked to be assessed). These two issues distort the quality of self-evaluations which contributes to their weak associations with objective measures of creativity. In fact, [Reiter-Palmon et al. \(2012\)](#) found that the correlations between self-evaluations and objective measures (i.e., their actual performance in DT tests) are close to zero. Due to the low correlations, someone may question whether self-evaluation really assesses the same construct as evaluated in objective measures.

In contrast, self-evaluations are highly correlated with creative self-efficacy or personality, which is also often measured in self-reporting questionnaires. Thus, it may be fair to say that what is measured in self-evaluation may represent the extent to which individuals are ready to engage in creative work no matter how they actually perform. Because construct validity is not perfectly secured in self-evaluation, the challenges still remain when self-evaluation is taken for the criterion.

Challenges and Future Research Directions

When people ask about what the criterion of creativity is, someone may come up with Leonardo da Vinci while someone else may think of Jackson Pollock who reconstructed Mona Lisa in a modern way. Someone may even think of her classmate who drew a spooky Mona Lisa using jelly belly candies. Because they perceive the criterion of creativity differently from one another, how they operationally define creativity may vary. Operational definitions serve for the basis of assessment tools. A key question in measuring a construct is “does the instrument measure what it is intended to measure?” This is the core of construct validity. Because a criterion is what is purported to be quantified through the measure, validity of the scores quantified by the instrument is threatened when the criterion is not clearly defined as intended. However, it is still challenging to determine what should be selected for a criterion and how to select it.

One challenge is that people often choose the criterion of creativity upon their insight rather than the rational grounds of creative products. If ordinary people, for instance, believe creativity is only represented in eminent work or life-long accomplishments, they tend to believe that creativity may be strongly tied to extraordinary talents rarely seen in a general population including themselves. This belief is not only applied to themselves but also to others around them. They are likely to underestimate people, such as children, who do not have special talents or have yet to manifest their potential. Recall here that there are ultimate, intermediate, or immediate products which can serve for the criterion upon the purpose and context for which creativity scores are to be used, instead of applying their own personal belief of creativity.

Potential is primarily assessed with immediate products. Because products are regarded as more objective and measurable than potential, assessing potential is often questionable despite its significance, particularly in populations who have yet to gain enough opportunities to develop their creativity. Thus, it is important to identify measurable indicators of potential which include dispositional traits, developmental experiences, and thinking processes. Nonetheless, developing potential measures is not easy. For instance, dispositional traits may lower thresholds for certain behaviors. If people are unrestrained by social norms, this trait would make it more likely for them to refuse to endorse what is conventionally asked. Thus, their thought process and behaviors deviate from convention which is more likely to result in new ways of solving problems. Still, nonconformity doesn't guarantee creativity and may lead them to arrogance and hostility toward others.

Diversifying experiences may serve creative development in a similar way as unconventional dispositional traits ([Damian & Simonton, 2015](#)). For instance, some people have various adversities in their life such as family loss, poverty, and the discrimination which is attributed to their status as minority or their harsh backgrounds. Because these experiences are rare and highly unexpected in general populations, they would formulate their perspectives through various unique experiences with high emotional intensity. Because these diversifying experiences equip people with new perspectives which are not restricted to social norms, people with these experiences are likely to turn into eminent creators. Yet, this link is only apparent in artists but not in scientists, implying differences subject to domains. Put differently, the prediction of creative potential, such as dispositional traits and developmental experiences, may vary by contexts and domains which leads us to hesitate regarding potential as the eligible criterion of creativity.

Lastly, because the measurable indicators of creative potential often result in poor or unstable psychometric qualities, creative potential may be argued to be a fluffy construct which makes it questionable as a criterion of creativity. Poor and unstable psychometric qualities are attributed not only to fluffy constructs but also to the way in which the constructs are measured. For instance, self-reporting questionnaires are the most preferred as well as widely used in measuring potential despite the limitations of using self-perception for the criterion of creativity. Still, potential can be measured in many different ways by cutting down subjectivity as well as intensifying the link of potential measures to actual creative performance and accomplishment. Tools measuring potential objectively need to be further developed and validated.

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Criticism

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Glossary

Biases	Predilections that result in people over an understanding the value or workability of potential problem solutions
Criticisms	Corrections or negative evaluations of others' ideas on potential actions
Idea evaluation	Process for evaluating alternative ideas generated for potential use in social creative problems
Ideas	Potential solutions to a creative problem
Interpersonal criticism	Criticism of ideas produced by others
Personal conflict	Negative social interactions with others based on personal appraisals
Self-criticism	Personal criticism of ideas a person has generated
Technical conflict	Disagreements among multiple people about the technical value of ideas

Criticism

Creative problem solutions, the production of original, high quality, and elegant solutions to novel, complex, ill-defined or poorly structured problems, provide the basis for the development of innovative new products or services. When people are presented with novel, complex, ill-defined problems, however, many potential solutions, many ideas for problem-solving, are possible. And, students of creativity have long recognized the fact that people typically generate multiple ideas for solving creative problems. Indeed, this key fact underlies [Guilford's \(1970\)](#), and others', work on divergent thinking.

Ideas for solving creative problems, however, are fuzzy. By the term fuzzy we mean to imply that it is not evident either to the person generating ideas or others appraising these ideas as to how successful any given idea will be in solving the creative problem at hand. This inherent uncertainty is the basis for the old adage – don't criticize creative ideas. And, in fact, many involved in promoting creativity explicitly tell people don't criticize ideas, be open to the possibilities.

By the same token, in creative problem-solving people, in general, and creative people, specifically, due to their divergent thinking capacities, produce far too many ideas to allow viable creative problem solutions to be pursued. As a result, virtually all models of creative thinking hold that following idea generation ideas must be evaluated, and a small number, often a single idea, is selected as a basis for the creative problem-solving effort. The notion that ideas must be evaluated, however, implies criticism of ideas is critical to successful creative problem-solving efforts. Accordingly, in the present effort we will examine how criticism contributes to creative performance. We will begin by considering the importance of idea evaluation in creative thought. Subsequently, we will consider the role of self-criticism and interpersonal criticism in the production of creative problem solutions.

Idea Evaluation

[Mumford et al. \(1991\)](#) proposed the most widely accepted model of creative thinking processes. This model holds that creative problem-solving requires effective execution of eight distinct process: 1) problem definition, 2) information gathering, 3) concept/case selection, 4) conceptual combination, 5) idea generation, 6) idea evaluation, 7) implementation planning, and 8) adaptive monitoring of solution implementation. [Mumford et al. \(2012\)](#) have shown this process model does, in fact, provide a compelling description of the key processes involved in creative thought.

In initial work on the significance of idea evaluation, Runco and his colleagues provided rather compelling evidence for the significance of idea evaluation in creative thought. For example, in one study by [Runco and Vega \(1990\)](#), school children

were asked to complete measures of their divergent thinking ability. Scores on a measure of idea evaluation, assessed by children's ability to appraise idea popularity, were found to be strongly related to their performance on measures of divergent thinking ($r = 0.50$).

Skill in idea evaluation is not simply a prerogative of children. Silvia (2008) presented undergraduate students with four divergent thinking tasks. Participants were asked to appraise which of the ideas they produced were most creative and judges, an external panel, appraised idea creativity. It was found that participants' appraisals of idea creativity closely corresponded to those of external judges – a finding which suggests that people can accurately evaluate the ideas they have produced.

Of course, the key criteria employed in these studies are appraisals of ideas produced as opposed to the generation of creative problem solutions. This issue, however, has been addressed in a study by Lonergan et al. (2004). In this study participants, undergraduates, were presented with either ideas of known high quality or known high originality identified in an earlier study by experts in this work domain. Participants were asked to appraise ideas with respect to operative efficiency or innovation potential, and, subsequently, formulate a marketing plan for the new product under consideration – the 3D holographic television. A panel of judges appraised the quality and originality of these marketing plans or problem solutions.

It was found that the highest quality and most original solutions to this creative problem emerged when high quality ideas were evaluated with respect to innovative standards and when highly original ideas were appraised with respect to operative efficiency standards. Apparently, idea evaluation, and criticism, were employed in a compensatory fashion to improve the viability of ideas selected for problem solving. Thus idea evaluation is an active creative thinking process. Moreover, it appears people can apply a number of different standards in evaluating ideas – standards that lead to acceptance or rejection of ideas and the progressive refinement of these ideas.

These observations, however, bring to fore a new question: what standards do people routinely apply in evaluating creative ideas? Blair and Mumford (2007) presented undergraduates with a large set of ideas that might prove of value to a non-profit foundation concerned with solving social innovation problems. Participants compared pairs of ideas and selected a final set of ideas they believed should be pursued by the foundation. Judges, earlier, however, rated key attributes of these ideas. It was found that people preferred ideas that were easy to understand, provided short term benefits to many, and were consistent with prevailing social norms while they tended to reject risky, time consuming, original ideas. Thus, the standards people apply in idea evaluation often may lead to the rejection of creative ideas.

Licuanan et al. (2007), however, have shown under certain conditions people are more likely to evaluate original, creative, ideas more positively. They asked undergraduates to evaluate the originality of marketing campaigns developed by six teams where the level of idea originality was varied along with the amount of information provided about interactions among team members. Manipulations were induced, or not induced, to encourage deep analysis of idea originality and team interactions. And, original ideas were more likely to be identified by those who thought deeply about ideas and their implications, as well as the interactional processes giving rise to these ideas. Thus evaluation, and acceptance, of ideas required extended deep analysis of the implications of ideas in context.

Self-Criticism

Taken as a whole, it appears people can not only evaluate ideas in idea evaluation, they must also criticize ideas with respect to standards. The question that arises at this juncture, however, is what standards do people employ in evaluating ideas and criticizing ideas with respect to certain standards. In self-criticism, the standards imposed in idea evaluation are selected by the individual working on the creative problem solution while in interpersonal criticism the standards imposed in idea evaluation are selected by others.

In an initial study of self-criticism, Kozbelt (2007) obtained historic commentary Beethoven provided with respect to various compositions. Some seventy explicit self-criticisms of various compositions were found in various letters or conversations. Beethoven's self-criticisms, both positive and negative, were found to be strongly related to 1) listener hours, 2) expert ratings, and 3) number of recordings of a given piece. Moreover, the strength of these relationships increased as Beethoven aged. Thus, it appears professional expertise is one key variable shaping productive self-criticism.

Professional expertise, and the standards for creative performance associated with this expertise, arises from three noteworthy sources. One source is evaluation in the profession. Professional evaluation provides standards for appraising ideas or creative work. Second, interactions with colleagues in accomplishing professional work also provides standards for evaluating creative work. And, in fact, prior studies have indicated creative people working in various fields typically establish contact with other creative professionals, perhaps, in part, to identify and elaborate the standards they apply in evaluation their own work. Third, as people acquire expertise, feedback from experience allows them to establish personal standards for evaluating professional products and ideas.

Although expertise appears critical to effective self-criticism it may not be the only influence on evaluation of the ideas a person has produced. Silvia and Phillips (2004) asked undergraduates to work on the alternative uses tests (e.g., alternative uses for a brick), a common measure of creativity, where judges appraised the creativity of the alternative uses listed. Self-evaluation was manipulated through expectations that participants would or would not be appraised for creativity. In addition, expectations for performance improvement were manipulated. It was found that self-evaluation inhibited effective evaluation but only when people did not

expect to improve over time. This pattern of findings suggests that creative self-efficacy may, along with expertise, contribute to effective self-criticism.

In addition to expertise and creative self-efficacy, however, at least three other variables appear to contribute to effective self-criticism. First, [Strange and Mumford's \(2005\)](#) findings suggest that reflection on past personal experience, self-reflection, may contribute to effective self-criticism. Second, [Medeiros et al. \(2014\)](#) findings suggest that explicit analysis of constraints may contribute to idea evaluation by providing a more elaborate set of standards for evaluating creative ideas. Third, [McIntosh et al. \(2020\)](#) findings indicate that when people look downstream, or forecast, the implications of how an idea might "play out" in the future it may contribute to more effective self-criticism of creative ideas.

Self-criticism does not only occur when one evaluates their already produced ideas, however, but also during the generative activities that lead to the production of those ideas. It is often necessary to refine or alter certain aspects of an idea before its implementation if one is to reach a viable solution, especially in creative scenarios. [Kozbelt \(2006\)](#) asked participants, both art students and non-artist undergraduates, to evaluate each of twenty-two in-progress iterations of Matisse's 1935 *Large Reclining Nude*, one of which being the completed work, in a random order. It was found that quality ratings varied considerably as the painting evolved, although the final painting was still considered to be of the highest quality. Thus it appears that as creators evaluate during generative activities novel ideas may change their perceptions of the problem situation. Although modifications may temporarily increase or decrease the quality of an idea, self-criticism and metacognition contribute to effective generation of creative problem solutions.

In a further study of dynamic evaluation, [Kozbelt and Serafin \(2009\)](#) asked artist and non-artist undergraduates to evaluate the quality of numerous in-progress states of twenty emerging drawings, half of which resulting in highly creative outcomes and half resulting in relatively non-creative outcomes, presented in a random order. They found that trajectories of quality for low-creativity works were consistently incremental and additive while quality trajectories for high-creativity works were more jagged with substantial positive and negative fluctuations over time. A follow-up study by [Serafin et al. \(2011\)](#) asked artist and non-artist undergraduates evaluated the quality of in-progress drawings in a fixed order – the sequential order in which they were originally created. Although they concluded that random presentation is a better methodology for studying subjective assessment of creative output, their results fell largely in line with those of the previous study. This pattern of findings suggests that individuals in creative problem scenarios engage in an interactive hypothesis-testing dynamic, where they may not necessarily predict the outcomes of incremental changes during generative activities, but instead evaluate ideas after their implementation. Thus individuals can take risks that incrementally decrease the quality of a creative work without sacrificing final quality as long as they are able to effectively evaluate the consequences of the modification after it has been made.

Interpersonal Criticism

In an initial study of interpersonal criticism and creativity, [Dailey and Mumford \(2006\)](#) asked undergraduates to assume the role of a member of a review panel appraising proposals that might, or might not, be funded by a foundation. Participants were asked to appraise either three ideas drawn from the educational domain or three ideas drawn from the public policy domain. In their appraisals, they were asked to estimate the resource requirements for pursuing the idea (e.g., time to develop, finances needed) and likely outcomes if the idea was implemented (e.g., positive benefits, organizational disruption). Because all ideas reflected prior real-world cases of innovation, actual resource requirements and outcomes were known. The key outcome measure was how close were participants in estimating actual resource requirements and outcomes when evaluating others' ideas – interpersonal criticism.

Undergraduates of course know more about the educational domain than the public policy domain. Moreover, they were told either the panel's recommendation would be followed in deciding which proposals would be funded (high implementation intentions) or their recommendations were simply informative (low implementation intentions). It was found people's appraisals of others' ideas were quite accurate when they had expertise in the domain and they believed their evaluations would be acted on. Thus expertise and motivation to invest expertise in the evaluation of others' ideas appears critical to effective interpersonal evaluation – not just self-criticism.

The reason expertise and motivation are critical to viable interpersonal criticism has been examined in a study by [Gibson and Mumford \(2013\)](#). In this study undergraduates were asked to assume the role of a marketing manager and provide an advertising campaign for a new product line being fielded by a clothing firm. Final campaigns were appraised by judges for quality, originality, and elegance. Prior to preparing these campaigns, however, participants were presented with a set of candidate ideas by teams reporting to them and asked to provide a written critique of these ideas. Judges coded the criticisms provided with respect to number, amount or length, depth, usefulness, range, complexity, isolation, specificity, risk sensitivity, and operational relevance. In addition, the complexity of candidate ideas was manipulated.

It was found the most creative advertising campaigns were produced by those who provided a limited number of deep criticisms bearing on the ideas presented. Thus, focus and expertise, variables which make it possible for people to boil things down and produce deep criticisms, contribute to viable interpersonal criticism. However, viable interpersonal criticism became more difficult for participants as the complexity of the task increased. Apparently, people need time and space to think deeply about the potential problems in ideas if they are to provide the kind of criticisms that will make a difference in creative efforts.

Social Process

Interpersonal criticism, of course, is common in virtually all real-world creative efforts. Creative people at work have bosses, or leaders, and leaders provide followers with critical feedback on the work they have accomplished – feedback creative people, typically, actively seek out. In the real world much creative work occurs in teams. And, team members typically criticize the work of other team members. Thus, interpersonal criticism seems endemic to real-world creative efforts.

Because interpersonal criticism is a distinctly social phenomenon one would expect that various attributional processes would influence the acceptance of criticism and the adoption and/or refinement of creative ideas. In keeping with this observation, it has been found when the criticism is perceived as legitimate, criticism provided by a leader or an expert, it is more likely to be accepted and more creative problem solutions will emerge. Criticisms are more likely to be accepted, and acted on, when there is a high level of trust between the critic and the person producing the creative idea. In general people are more likely to accept criticism from higher status people – especially when the person is perceived to have expertise and credibility. Finally, criticism is more likely to prove valuable when it is provided under conditions where the target of the criticism has the time and resources needed to think in some depth about the criticisms being leveled at their idea.

Perceived expertise, status, and trust in the critic, along with providing the criticism under appropriate conditions, apparently, influences the impact and value of interpersonal criticism of creative ideas. However, all these variables speak to the conditions under which, or by whom, criticisms should be provided in creative efforts. A key question which remains, however, is what should be the content of the criticisms provided?

Reiter-Palmon et al. (2012) in a review of the impact of team processes on creativity and innovation, came to a straightforward conclusion in this regard. Viable criticisms of creative ideas by others should be based on objective technical considerations not personal criticisms of the person doing the work. Indeed, personalized criticisms may act to undermine a positive creative climate. Farh et al. (2010) findings, in a study of some seventy information technology project teams extends this line of argument. They found that interpersonal criticism was most valuable when it occurred at moderate levels and occurred early on in project work. Thus, even technical criticism, if it is unrelenting and occurs after people have invested much in the creative idea, may prove problematic. As a result, the intensity and timing of interpersonal criticism must be managed if it is to prove of real value in enhancing the success of creative efforts.

Conclusions

The old adage holds don't criticize creative work. In fact, the various studies examined in the present effort lead to a very different conclusion. Criticism is inherent in all creative efforts because the many ideas people produce for solving creative problems must be evaluated – and, evaluation implies criticism. In keeping with this observation both self-criticism and interpersonal criticism have been found to contribute to the success of peoples' creative problem-solving. Moreover, self-criticism during generative activities appears critical to the effective refinement and modification of creative ideas.

Of course, caution must be exercised when criticizing ideas. Personal criticisms, criticisms irrelevant to the technical merits of the idea, have no value. Criticisms should be appropriately timed, and people should think, and think deeply, before they criticize either their own or others' ideas. Perhaps even more critically, those providing the criticisms must know what they are talking about. Viable criticisms appear to be based on real expertise – both self-criticisms and interpersonal criticisms. In fact, given the impact of deep criticisms, based on expertise, on the success of creative efforts, we need to know more about how expertise influences the value and impact of criticisms. We hope the present effort provides an impetus for further work along these lines.

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Crowdsourcing

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Introduction

Crowdsourcing—a portmanteau of words crowd and outsourcing—refers to outsourcing of a task to a large group of unknown people. Different from a usual outsourcing activity, the task is not assigned to a designated agent but is opened up to an unspecified group of individuals (i.e., the *crowd*) typically via the Internet. Crowdsourcing is increasingly used for wide range of tasks. Some of these tasks do not require creativity at all (such as picture tagging, data entry, text editing, or translation) and use of crowdsourcing in such tasks is often motivated by cost and speed advantages of crowdsourcing over alternative outsourcing opportunities (or over doing a task internally).

What is of interest for this entry is use of crowdsourcing for tasks that require creative thinking. Indeed, crowdsourcing is used for harnessing creativity of the *crowd* for various creative outputs (e.g., ideas, designs, solutions, codes etc.) spanning across different domains within science, arts and business. In science, for example, crowdsourcing contests (also referred to as challenges) helped tackling some vexing innovation problems in disciplines such as physical sciences, chemistry, computer sciences, biology, medicine and many others. The challenges ranged from breakthroughs in the discovery of new drugs to designing algorithms that can transform diagnosis of some diseases. Businesses also often turn to crowdsourcing, for example, by creating online communities for consumers to freely share their ideas for new products (and interact with each other in the process of idea generation) or by organizing design competitions for marketing material such as logo designs or video ads.

The term crowdsourcing was coined relatively recently, in an influential Wired article by Jeff Howe in 2006, and the act of crowdsourcing is often viewed as a new approach. Crowdsourcing, however, has a long history—it has been an effective way to find solutions to some important historical problems and was catalyst for many significant inventions. In the next section, I start with providing a brief history of crowdsourcing creativity, with some illustrative historical examples, to put current crowdsourcing practices in context. I then explain the two main forms of modern crowdsourcing. Next, I discuss why crowdsourcing works for creativity and summarize academic research related to benefits of crowdsourcing. A chapter on crowdsourcing and creativity will not be complete without considering potential downsides of the use of crowdsourcing for creative purposes. I therefore focus on some important challenges entailed in crowdsourcing and discuss ways to address these challenges in the subsequent section. I conclude with a discussion of ethical issues in crowdsourcing creativity.

A Brief History of Crowdsourcing Creativity

The origins of using crowdsourcing for creative outcomes can be traced back to as early as 1714—the Longitude Challenge, or the challenge of being able to determine the position of ships in sea. This was one of the greatest scientific problems in the 18th century; it not only had tremendous economic implications, given the importance of it for a greater control in the world's oceans, but also meant saving thousands of lives. In an attempt to solve this challenge, British Parliament has passed the Longitude Act with £20000 prize (about two million pounds in today's value) for an invention that reliably determines longitude in sea. The expectation of the "Board of Longitude" was that only astronomical methods are likely to address this problem—a view that was also strongly shared by Sir Isaac Newton. To the astonishment of the Board and scientists of London, however, the solution was not based on astronomy and came from an entirely unexpected source. A marine chronometer developed by John Harrison, the son of a carpenter and self-thought clockmaker from Yorkshire, was the best solution to perhaps the most pressing scientific problem of his time.

Britain was not the only country where the creative power of the *crowd* was being leveraged to tackle complex innovation problems in the 18th century. In 1783, then French king Louis XVI offered a generous prize for an innovative method that enables

decomposing sea salt economically. About a decade later, the French Directory, launched a challenge for a breakthrough in the preservation of food, with 12,000-franc prize, which eventually led to discovery of canned food.

The use of crowdsourcing has continued in the next centuries. For example, in 19th century, French Emperor Louis Napoleon III offered a sizable prize for a cheap butter alternative intended for military and lower classes. The winner was French chemist Hippolyte Mège-Mouriès with an invention he called oleomargarine, or the margarine as it is called today.

In more recent history, the *crowd's* creativity led to design of one of the most iconic architectures of the 20th century: Sydney Opera House. The design was generated in response to an international competition for “a National Opera House at Bennelong Point” in 1950's. Danish Architect Jørn Utzon was selected as the winner among 233 entries from 32 different countries.

The examples above are just some of the many important historical innovation problems that have been solved via crowdsourcing. From fire extinguishers to hydraulic commercial turbine, many other inventions have been generated as a response to crowdsourcing.

The golden age of crowdsourcing creativity however coincides with growth of the World Wide Web and especially the Web 2.0 at the turn of the 21st century. Coupled with other advances in information and communication technologies, the creative potential of crowdsourcing has grown remarkably in the digital age. More specifically, these technologies enabled access to knowledge and creative potential of people at a global scale. Some well-known examples illustrating this scale include TopCoder—a crowdsourcing platform for software development with over a million members who have participated some of the thousands of contests—and InnoCentive—a platform in which hundreds of thousands of members from all over the world has achieved an astonishing 85% success rate in solving challenging innovation problems (that come from organizations like NASA, Toyota and many others).

Main Forms of Crowdsourcing Creativity

Crowdsourcing creativity essentially takes two main forms based on whether those platforms rely predominantly on collaboration or competition of the *crowd*.

The first form is *crowdsourcing communities* (also called as collaboration-based crowdsourcing). As the name implies, in this form of crowdsourcing, members of the *crowd* interact and collaborate with each other in the process of generating creative outcomes. The contribution in such communities are often on an ongoing basis (rather than one-off). With regards to the type of activities the *crowd* undertake in the community, there is substantial variance. It ranges from writing novel software codes to the development of new product concepts. What is common across these communities however is that the *crowd* collectively produces creative outcomes.

One example is OpenIDEO platform, developed by the renowned design firm IDEO, where a community of designers tackles complex social problems such as those related to human rights or water sanitation. Another example is open source software (OSS) communities in which voluntary programmers from all over the world contribute new codes for extensions to a software, source code of which is made publicly available (typically via the Internet). Perhaps the most well-known open source project is the Linux operating system, developed by Linus Torvalds a famous champion of free software movement. In a similar vein, some companies (e.g., Dell, Starbucks, Lego) have created their own brand communities for the *crowd* (which consists mainly of their consumers) to share their ideas for new products and services (and other brand-related issues), and comment on each other's ideas.

The second form is *crowdsourcing challenges* (sometimes also referred to as crowdsourcing contests/competitions or tournament-based crowdsourcing). In these challenges, *crowd* members compete with each other to generate the most creative outcome to a problem. The winning outcome is often rewarded with a financial reward that can sometimes be worth millions of dollars depending on the importance or complexity of the problem. Unlike crowdsourcing communities, in which collectivity and collaboration is emphasized, these challenges encourage independent experimentation.

One example is the Crowdspring platform—a global website to run graphic design competitions (e.g., logos, websites, brochures etc.) with over 210,000 members. Another example is XPrize which has launched numerous challenges in wide range of domains including Space, Robotics, Environment and Transportation. Their first \$10 million challenge, Ansari XPRIZE, for example, was for a breakthrough that would make private spaceflight commercially viable; this challenge has led to generation of important discoveries in this domain and has often considered as the main driver of the \$2 billion worth private space industry. Adopting similar structure and principles, NESTA (National Endowment for Science, Technology and the Arts) UK also runs several challenges with substantial prizes. For instance, one of their recent challenges, named after the famous Longitude Prize, offers £10 million prize for solutions that can help overcome antibiotic resistance problem.

It is worth noting that some crowdsourcing platforms may take a hybrid form, i.e., may entail challenges with collaborative elements or the other way around (i.e., may have community with some contests). For example, Climate CoLab platform, found by MIT to address global climate change problem, runs contests while also providing open spaces for interactively developing solutions to problems that *crowd* members deem important. Similarly, some platforms (e.g., InnoCentive) allow/require *crowd* members to form teams with other members; the teams then compete with one another generate to win a challenge.

Benefits of Crowdsourcing Creativity

Crowdsourcing is proving to be an effective tool to harness the collective creativity of people to address wide range of problems, as also illustrated by some of examples provided in the previous sections. The main creative value of crowdsourcing could be

attributed to two unique aspects of it: *scale* and *diversity*. That is, modern crowdsourcing operates at an unprecedented *scale* and involves an unparalleled level of *diversity*, both of which have important implications for creativity.

First, crowdsourcing brings a very large group of people together to channel their energies toward generation of a creative outcome. The crowd could comprise of hundreds, thousands and sometimes hundreds of thousands of people. From a simple probabilistic standpoint, more people means more contributions which in turn means having greater chances of exceptionally creative contributions.

It is therefore not surprising that a substantial portion of prior research has focused on what motivates people to participate to crowdsourcing initiatives. Most of this research has used self-determination theory (SDT) (Ryan and Deci, 2000) as their main theoretical framework to study motivations in this context. In this theory, motivation is considered to have a continuum in which extrinsic motivation (i.e., engaging in an activity for external contingencies) is at one hand and intrinsic motivation (i.e., engaging in an activity for the sake of activity itself) is at the other end. Between these two motivations, various forms of internalized extrinsic motivations (i.e., engaging in an activity to achieve a self-selected and personally valued goal) reside. The distinction between these three types of motivations is based on their relative level of autonomy in self-regulation. Compared to intrinsic motivation, behavior driven by internalized motivations feels less autonomous as it is not naturally driven by the activity itself, but by an external contingency. It is however more autonomous than extrinsic motivation as the process of internalization transforms external contingencies into personally valued reasons for engagement.

Majority of the motivation research on crowdsourcing has focused on a specific context: OSS communities. Specifically, scholars have documented rich evidence regarding the importance of intrinsic and extrinsic motivations as well as several internalized motivations that drive members to contribute their software codes in such communities. These internalized motivations include willingness to improve programming skills, reciprocity expectations, social motivations, altruism or one's own need for the software (von Krogh et al., 2012). Similar types of motivations were identified for various other crowdsourcing communities and challenges. In particular, prior research found that enjoying the creative process, learning, gaining status, social identification, or winning an external outcome such as prizes are the main reasons for crowd's participation (Acar, 2019).

Recent research has also explored how to motivate new *crowd* members to sustain their contributions when their ideas are not chosen for implementation. This makes up a very large part of the *crowd*, given that, by the very nature of crowdsourcing, only a small portion of the contributions could be selected to follow up. For example, in crowdsourcing challenges, typically only one or a few winners are selected out of hundreds of participants. It was shown that, somewhat counterintuitively, actively rejecting new, non-winning *crowd* members is an effective way to strengthen relationships, as this signals that their future contributions are desired, which in turn increases those members' willingness to take part in future crowdsourcing initiatives (Piezunka and Dahlander, 2019).

Researchers have started to go beyond looking at what motivates people to take part in crowdsourcing initiatives, and have addressed how those motivations relate to different outcomes such as crowd's level of effort and activity. For example, Boons et al. (2015) have shown that social motivations (e.g., feelings of pride) are a significant driver of members' activity in a crowdsourcing platform. Arguably a more important understanding the relationship between different types of motivations and creativity. Recent research has taken a step to explore this link: it was shown that (i) motivations have different effects (i.e., positive, non-significant, negative) on appropriateness dimension of creativity, (ii) reward size has different effects on novelty and appropriateness dimensions of creativity (Acar, 2018, 2019).

The second unique aspect of crowdsourcing is its unprecedented diversity. That is, crowdsourcing opens up a task not only to usual suspects (e.g., experts, insiders to a domain) but also to outsiders. The creative value of including outsiders is that they might have novel perspectives (from their own domain) for a problem and that they are not bound by rules and norms within a field or organization, both of which could stimulate generation of creative outcomes. Indeed, empirical research in the context of crowdsourcing (and anecdotal evidence from several breakthroughs in the history of science) has shown that outsiders can outperform insiders in terms of their creativity in solving complex innovation problems (Acar and van den Ende, 2016; Jeppesen and Lakhani, 2010). The results were consistent both for being outsider in terms of technical background (e.g., disciplinary expertise) or social background (e.g., gender).

Challenges With Crowdsourcing Creativity

The scale and diversity that crowdsourcing brings, despite the all the potential benefits for generation of creativity, also brings about some important challenges to harness the creative potential of crowdsourcing. The scale of crowdsourcing sometimes means receiving overwhelming number of contributions from the *crowd*. For example, in a recent crowdsourcing initiative of Netflix (for an algorithm to improve existing Netflix algorithm by at least 10%), almost 45,000 submissions were made and the winning submission had more than 100 individual algorithms. The sheer volume of contributions could make it extremely challenging and resource intensive, if not impossible, to properly evaluate each contribution. That is, recognition of truly creative outputs becomes highly difficult among many other substandard submissions. This issue becomes even more problematic when a large portion of ideas are of questionable quality (which often is the case). Because of, in part, diversity of the *crowd* many contributions are useless for different reasons such as not satisfying challenge requirements, being irrelevant or vague etc.

The case of BP illustrates the paradox of openness, or the double-edged sword of scale and diversity, in crowdsourcing. In April 20, 2010, an explosion in BP's DeepWater Horizon rig caused the largest marine oil spill in history and one of the worst

environmental catastrophes of recent times. Millions of gallons of oil were spilled into Gulf of Mexico. BP turned to crowdsourcing to generate novel approaches to clean up the spill and prevent further environmental impacts in the region. The *crowd* was willing to help; the company received over 120,000 responses from more than 100 countries within just a few weeks. A massive effort was undertaken to sift through these ideas, however a large majority of them were at best of questionable quality. The Guardian newspaper described BP's crowdsourcing endeavor as "a lot of effort for little result".

These paradox of openness in crowdsourcing is arguably the most important conundrum for organizers of crowdsourcing initiatives to navigate. It can have a direct negative of on the value derived from crowdsourcing and discourage use of it altogether. This is because a large number of low-quality contributions generates a significant, but unnecessary resource burden—i.e. evaluation these contributions require substantial effort and time despite being of limited to no value. Moreover, having to deal with an overwhelming number of low-quality contributions could affect how these contributions are handled. Recent research has indeed shown that receiving too many ideas biases idea evaluation in favor of familiar ideas (instead of novel ones) (Piezunka and Dahlander, 2015). In addition, A large *crowd* means increased competition among *crowd* members (especially in crowdsourcing challenges), and therefore might attenuate their expectancy of winning extrinsic rewards. It could in turn reduce creative effort and creativity of *crowd* members (Boudreau et al., 2011).

One solution to deal with overwhelming number of contributions is involving the *crowd* in the evaluation process by, for example, letting them vote on contributions. In its crowdsourcing platform, Lego, for instance, asks the *crowd* to show their support for designs they like and only reviews the designs that achieve a certain level of backing from others. This process, however, may also be prone to bias as illustrated by recent research: crowd members' ratings are often reciprocal in nature (Hofstetter et al., 2018). That is, *crowd* members vote for others to return a favor instead of evaluating a contribution based on its true creativity.

Another potential solution to navigate the openness conundrum in crowdsourcing is focusing only (or at least mainly) on appropriate solutions (Acar, 2019). The reasoning is that appropriateness of contributions is a necessary (but not sufficient) for them to be considered creative; contributions that do not meet the main constraints of a task cannot be one of the most promising creative outputs. Inappropriate contributions therefore, regardless of their novelty, aren't worthy of consideration as they distract attention from contributions that hold greater potential. In sum, having fewer but more appropriate solutions might be a promising way to better leverage the creative value of crowdsourcing. One way to achieve this is designing incentives in crowdsourcing initiatives in a way that promotes participation of people who are more likely to generate appropriate ideas. Prior research has provided some insights in this regard. It was found that extrinsic and intrinsic motivation leads to generation of more appropriate ideas whereas prosocial and learning motivations is associated with lower appropriateness. In light of this, organizers of crowdsourcing initiatives are likely to be better off by encouraging those with high extrinsic motivation and intrinsic motivation while at the same discouraging those with high prosocial and learning motivations.

Scholars have documented evidence for other ways to improve creativity of contributions generated in crowdsourcing initiatives. In addition to the findings related to motivation and creativity discussed before, it was shown that feedback (including negative feedback), task variety and perceived autonomy improve creativity (e.g., Garcia Martinez, 2015; Wooten and Ulrich, 2017). It was also found that experiencing success could be detrimental for subsequent creativity. Studying Dell's IdeaStorm crowdsourcing community, Bayus (2013) has found that members who experience early success with their ideas tend to become less creative because they are inclined to propose very similar ideas to the ideas that brought success to them. He also found that this tendency could be alleviated if successful members diversify their activity in the community by, for example, commenting on other members' ideas.

Ethical Considerations

Crowdsourcing creativity entails several important ethical issues. One important concern is potential exploitation of the *crowd* by not providing fair compensation. Because most crowdsourcing initiatives for creativity typically do not involve any financial rewards or only reward a few select people, most efforts and contributions of the *crowd* are uncompensated. This led some to argue that crowdsourcing creativity is inherently exploitative. Others, however, highlight the wide range of motivations, above and beyond financial rewards, and the voluntary nature of participation in crowdsourcing initiatives. It could also be argued that rewards in crowdsourcing could provide attractive opportunities for people from the developing countries.

Some evidence indicates that *crowd's* perceptions of what makes a fair reward is complex. For example, it was found that not giving any financial reward at all could be better than providing an unfair reward indicating that the *crowd* might have different meanings attached to unpaid and paid crowdsourcing initiatives (e.g., a fun game vs. a badly paying job) (Acar, 2018). In a similar vein, other factors such complexity of a task, or required level of technical expertise or elaboration in that task could also affect perceptions of fairness. This suggests that perceptions about fairness of crowdsourcing is more complex than simply looking at minimum wage calculations—other factors discussed above should also be taken into account.

Another important ethical issue is potential opportunistic behavior (in terms of misappropriation of creative outputs) by the organizers of crowdsourcing initiatives. This issue originates from the paradoxical nature of knowledge disclosure. That is, in order for the value of knowledge (or creative outputs in this case) to be determined, potential acquirer of that knowledge needs to obtain it without any commitments and cost. The knowledge could therefore be potentially misappropriated. Knowledge creators may hesitate disclosing their knowledge due to fear of such opportunistic behavior. Prior research has shown that such fears of opportunism is present among *crowd* members too—even among those who eventually opt for disclosing their knowledge (i.e., active

crowd members) and in well-known and established crowdsourcing platforms (Acar and van den Ende, 2015). An effective way to mitigate such fears is building trust which could, for example, be partly achieved by investing in transparency and communication regarding conditions related to ownership of contributions (e.g., intellectual property rights etc.).

All in all, organizers of crowdsourcing initiatives have moral responsibility to address these issues. This is not only essential from an ethical standpoint but also important for ensuring sustainability of crowdsourcing and deriving better creative value from it.

Conclusion

Crowdsourcing is a promising way to tap into collective creative potential of people. It provides a “playground” for some to hone their creative skills and enjoy their time while also providing many others an outlet to connect with others, contribute to something that matters, and sometimes gain concrete extrinsic financial and non-financial benefits. Despite some important challenges inherent in crowdsourcing creativity, it has proven to be an effective method to tackle various minor and major creative problems at least when designed and managed carefully.

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Relevant Websites

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- CrowdSpring Crowdsourcing Platform (<https://www.crowdspring.com>).
- InnoCentive Crowdsourcing Platform (<https://www.innocentive.com>).
- National Endowment for Science, Technology and the Arts (NESTA) Challenges (<https://www.nesta.org.uk/project/nesta-challenges>).
- openIDEO Crowdsourcing Platform (<https://www.openideo.com>).
- Topcoder Crowdsourcing Platform (<https://www.topcoder.com>).
- XPrize (<https://www.xprize.org>).

Culinary Creativity

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Introduction

The concept of culinary creativity has witnessed a growing public and professional interest over the last two decades, but it is still relatively under-explored academically. The practice of culinary creativity, however, has existed since people were required to be creative in the preparation of their food because of the scarcity of resources or could afford to be more lavish to increase the aesthetic pleasure of their meal creatively. But, it was not before the famous Spanish chef Ferran Adrià published the book 'Los Secretos de El Bulli' ('The Secrets of El Bulli') in 1998 that the concept of culinary creativity piqued public interest. Today almost every TV channel on the planet has a portfolio of more or less 'creative' cooking shows including both laypeople and professional chefs. Before that time, chefs were certainly using their creativity but considered it as a natural part of their artisanal work and craftsmanship without talking about it much.

Academically, culinary creativity is researched through a rather narrow lens that focuses on the upper echelons of gastronomy, called Haute ('high') cuisine, where cooking meets art and sometimes even science. One of the main reasons for this focus on haute cuisine is the institutionalized evaluation of culinary excellence and creative progress through yearly recognition in the leading restaurant guides, the Michelin and Gault Millau. Their publicly available evaluations make it easier for researchers to justify their choice of the sample when studying the creative person, creative process or creative product.

Unquestionably, culinary creativity also exists outside the realm of haute cuisine or the food on the plate and can be found in as diverse culinary fields as fast food, airline food, or home cooking, and regularly ignites inspiration for new gastronomic concept developments, multisensory experience creation or cooking machinery. The latter, developing cooking machinery, is often triggered by the process of finding a creative solution to a particular cooking problem. The famous French chef Michel Troisgros, for example, invented a machine to produce layers of milk skin on a large scale that he requires for his dish 'Raviole de lait caillé,' a ravioli that he makes from milk skin instead of dough. Initially, he started by boiling milk in a pot, like many would do for breakfast at home, and then waited for the milk to cool down to form a skin on top. This technique, though, would have been unusable for the demands of a professional restaurant where chefs need to reproduce a dish several dozen times per service.

More generally, a better understanding of culinary creativity is vital for the advancement of the hospitality and tourism industry that has long been considered a laggard with regards to creativity and innovation and is in urgent need of meaningful rejuvenation. This industry is not only the largest industry in the world, responsible for substantial economic value generation, but it is also one of the last remaining industries that can accommodate low- or semi-skilled workers and thus has a significant social responsibility.

Furthermore, one part of the hospitality and tourism industry, the gastronomic sector, has a rich cultural heritage and forms part of the so-called cultural and creative industries. Ever since culinary creativity escaped from the kitchens of the royal courts, France has contributed, perhaps like no other country in modern times, to the economic and cultural significance of gastronomy. France and its culinary tradition influenced generations of chefs with its sophisticated practices, intricate recipes, and elaborate aesthetics of presenting food. This contribution has recently been recognized by the UNESCO (United Nations Educational, Scientific and Cultural Organization), which declared the gastronomic meal of the French as an 'Intangible Cultural Heritage of Humanity' (<https://ich.unesco.org/en/RL/gastronomic-meal-of-the-french-00437>).

Another reason why researchers predominantly explore culinary creativity in haute cuisine is that culture tends to evolve through the influences of those practicing and shaping practice at the highest levels and who have the power to initiate institutional change. Haute cuisine has witnessed at least two, perhaps three, distinct institutional changes that went far beyond the creation of a new plate of food, involving almost paradigm-like shifts of cuisine styles. All of these changes were rooted in creativity.

Culinary Creativity and Haute Cuisine

The sociological literature has especially looked at the macro-level of culinary creativity by exploring the institutional changes in the field of haute cuisine. In this field, creative work in the professional kitchen was for a long time seen as merely being the refinement of the existing know-how and practices of the French culinary arts. More significant creative leaps in the past were often only recognizable by what could be described as shifts in cuisine paradigms. Similarly to the concept of scientific paradigms, there are paradigms of cuisines that go beyond the individual cuisine of a chef and describe a more aggregate level of cuisine based on agreed beliefs and assumptions that regulate the professional practice. Haute cuisine has witnessed four different types of cuisine paradigms: ancien régime cuisine, classical cuisine, nouvelle cuisine, and avant-garde cuisine. Now and then a new set of beliefs and assumptions develops, and when strong enough challenges the dominant cuisine, trying to initiate an institutional change of the currently dominant cuisine paradigm.

The first such change happened when the so-called ancien régime cuisine paradigm was slowly taken over by the classical cuisine paradigm that was triggered by the French Revolution in 1789. This movement fostered the opening of public restaurants, the codification of professional knowledge, and generally liberated chefs from the very restricted type of gastronomy celebrated in aristocratic or other elite households where chefs were regarded as bondsmen of the ruling classes (Ferguson, 1998; Rao et al., 2003). One of the leading proponents of this movement was the French chef Antonin Carême (1784–1833) who pushed the idea in his writings that haute cuisine is both science and art. He was followed by two other French chefs, Georges Auguste Escoffier (1847–1935) and Prosper Montagné (1865–1948), who, by then, represented a very different breed of chefs, more business-minded and often hired for their abilities to manage large kitchen brigades and create gastronomic identities for entire hotels. Perhaps the most prominent example here is the collaboration between chef Georges Auguste Escoffier and the famous Swiss hotelier César Ritz, who, in his function as manager of the Savoy Hotel London, hired Escoffier to manage the hotel's gastronomic outlets and staff. After years of experience in similar positions, Escoffier published *Le Guide Culinaire* in 1903 that became a standard for generations of chefs to come and is still considered the seminal reference of classical cuisine (Stierand, 2013).

Almost two centuries later, triggered again by major social unrest, the protests in France in May 1968, classical cuisine was subsided by the emergence of nouvelle cuisine that followed a new reflective philosophy of cooking based on truth, lightness, simplicity, and imagination (Rao et al., 2003). Chefs started to use transgression, the use of old cooking techniques in combination with new products, and acclimatization, the adoption of foreign cooking traditions, spices and seasoning, and developed a more self-expressive style of cooking with a greater degree of creativity, more detached from the strict rules of Escoffier's *Guide Culinaire* (Rao et al., 2003). Chefs like Alain Chapel, Michel Guérard, Paul Bocuse, and the Troisgros brothers Pierre and Jean, are notable examples of the nouvelle cuisine movement who expressed more liberal and 'anti-establishment' values in their style of cooking by de-complicating recipes and focusing on the product itself that was used at its seasonal peak and regional availability (Stierand, 2013). The philosophy of nouvelle cuisine made it much easier to apply certain aspects, such as foreign spices and seasoning for home cooking. Even haute cuisine dishes like Heinz Winkler's salmon in puff pastry, found entry to the private home kitchen, because it helped the amateur cook to produce a perfect piece of salmon through protecting it in puff pastry. But, and perhaps most importantly, it inspired many to become more mindful about food, cooking, and eating, giving birth to a number of iconic eateries such as Alice Water's 'Chez Panisse' in Berkeley, California, the fount of the fresh food movement in the US, or Fergus Henderson's 'St-John Restaurant' in London, UK, where he celebrates nose-to-tail eating.

The last significant change to the institutional field of haute cuisine is often wrongly associated with the term 'molecular gastronomy,' which is a branch of food science created by the physical chemist Hervé This and the physicist Nicholas Kurti (Cousins et al., 2010). The media jumped on the term and used it to describe a new style of cuisine that was spearheaded by chefs like Ferran Adrià, Heston Blumenthal and Thomas Keller, but who were, in fact, interested in an artistic style of cuisine based on a better scientific understanding of cooking that could help evoke new culinary experiences. These chefs always favored the term avant-garde cuisine (Stierand, 2013).

Perhaps less known to the public, many insiders consider the self-taught French chef Raymond Blanc, who made his career in the UK, as the godfather of this approach to cooking. He worked with Nicholas Kurti, who became in many ways his mentor, and together they wanted to improve professional cooking scientifically, and sometimes this would also provide possibilities to create new and meaningful culinary inventions. While avant-garde cuisine often appeared very cold and technical at its beginning, it became more and more natural. It eventually led chefs to include foraging, the sourcing of wild foods, in their cooking and the rediscovery of natural preservation methods such as fermenting. Notable examples of this new approach of avant-garde-cuisine are chefs René Redzepi from Denmark and Magnus Nilsson from Sweden.

As said earlier, creativity was a major vehicle for these institutional changes to happen. While classical, nouvelle and avant-garde cuisine represent cuisine paradigms, philosophies of cooking based on socio-cultural and professional assumptions and beliefs, they are often described through iconic dishes that were invented during these times. One of the most famous classical cuisine dishes is certainly Escoffier's 'Peach Melba,' a poached peach with vanilla ice-cream and raspberry sauce that Escoffier invented at the Savoy Hotel London in honor of the Australian soprano singer Nellie Melba. One of the most famous nouvelle cuisine dishes is the Troisgros brother's 'Salmon with Sorrel Sauce.' And the iconic dish of the avant-garde cuisine is certainly Ferran Adrià's 'Melon Caviar.' This dish is made from Cantaloupe melon juice enriched with Algin, a binding agent extracted from brown seaweeds, which is then put in syringes through which the juice is dripped into a calcic bath where the drops form a fragile shell around the juice and turn into caviar-like melon pearls.

Culinary Creativity as a Process

Empirical research on the process of culinary creativity is most often found in the management and organization studies (MOS) literature. Svejenova et al. (2007), conducted a longitudinal inductive study of the critical case of the famous Spanish chef Ferran Adrià to understand how he initiated institutional change through creativity.

Creativity researchers know a good deal about the creative person and the creative outcome, but the process in between that happens upstream in people's minds, often requiring a well-developed level of sensory knowing, is still under-researched from a personality, cognitive, affective and aesthetics perspective. Following the need of better understanding the creative process itself, Horng and Hu (2008) explored to what extent the creative culinary process is comparable to Wallas's classic model of the creative process. A later study (see Horng and Hu, 2009) extended their four-component model to include culinary performance. Then, perhaps providing a more aggregated view of a creative process, Svejenova et al. (2010) built on their previous study of top Spanish chef Ferran Adria and showed how his quest for creative freedom triggered distinct evolutionary phases of his individual business model.

Bouty and Gomez (2013) investigated creativity in three French Michelin-starred restaurants through a practice-based lens and described how chefs engage in three types of creative work, namely individual idea work, creative team work, and naming of the dish. This was followed by a study conducted by Stierand et al. (2014), who showed, based on in-depth interviews with 18 Michelin-starred chefs, that the phenomena of creativity and innovation in haute cuisine did not follow a sequential developmental process based on the principles of operations management. Instead, these phenomena are embedded in a system in which creativity is perceived as an embodied experience that is frequently guided by intuition and in which innovation is mostly the result of the audiences' social evaluation. Stierand and Dörfler (2016) focused on the aspect of intuition and showed how intuitive insight and intuitive judgment are instantaneous yet distinct and rapid processes that seem to be part of the creative culinary process.

The aspect of embodied experience and intuition was looked at in more detail by Stierand (2015) who used a practice-based lens to focus on the situated development of Michelin-starred chefs' high-level creativity, explaining how these chefs went through a master-apprentice relationship. In these master-apprentice relationships, the talented novice chefs developed their own socially appropriate creative voice through intelligent imitation of the master by becoming an improved version of themselves rather than a pale copy of the master. Master-apprentice relationships naturally consist of relational ties that Feuls (2018) explored from the broader perspective of culinary innovation as a relational phenomenon. She was building on Gabriel Tarde's relational sociology and identified three processes of innovating, namely repeating, adapting and differentiating, that chefs seem to follow and that influence the degree of novelty of the creative output (See Mentors).

A rather new but critical perspective for better understanding the process of culinary creativity was then introduced by Bouty et al. (2018: 156). They were interested in how creative teams are led in haute cuisine kitchens and looked through a practice-based lens at their combined research projects on haute cuisine restaurants. They inductively unveiled three dynamics of directing creative leadership practices that they labeled enabling, orientating, and complying.

Discussion and Conclusions

Culinary creativity includes "both the chef's willingness to come up with new concepts and techniques and his ability to do that through methods for creativity and organizing" (Svejenova et al., 2007: 547). Culinary creativity combines food science with art and culture, making it a nonlinear and heterogeneous phenomenon that frequently combines diverse techniques with culinary influences from different historical periods and cultures (Horng and Hu, 2008). More precisely, culinary creativity seems to sit in between the chef's individual culinary style that also includes commercial considerations and a more globally expanding culinary tourism industry with customers demanding an authentically local cuisine cooked to the highest international standards (see Horng and Hu, 2009).

One of the earliest conceptual MOS contributions regarding culinary creativity discussed the link between culinary innovation and the chef's creativity and artistic aspirations that they argued is formed and influenced by the chef's lifeworld (Stierand and Lynch, 2008). Exploring the phenomenology of creativity is important because it can provide a thicker understanding of the micro-practices in and in-between creative work. For example, the studies above on relational ties and the master-apprentice relationship would not have been possible without tapping into the lived experiences and lifeworld of creative chefs.

Through phenomenological and exploratory style research approaches it was possible to find out that chefs who cook a more classical cuisine seem to apply their creativity predominantly to the creation of new dishes, aiming to evoke new emotions through unusual textures or food combinations (Gomez and Bouty, 2009). Avant-garde chefs like Ferran Adrià, in contrast, seem to look more beyond the plate and are fascinated by developing new techniques and concepts, searching for inspiration in other domains and then applying a disciplined trial-and-error process (Svejenova et al., 2010). Moreover, research on the master-apprentice relationship showed that talented master-apprentice chefs typically wander from more classical to the more avant-garde type chef to develop their creativity (Stierand, 2015).

Future research on culinary creativity can and should harvest the low hanging fruits, the big questions that seek answers. One such low hanging fruit is the widening of the research lens to include all levels of the culinary field, at all skill levels, looking at the entire spectrum of the culinary arts, including the person, process, product, and press (See the Four P's of Creativity).

The degree of novelty and nature of appropriateness varies depending on one's creative competence and the perceived or assumed expectations of the audience. It is a different scenario if the audience is family members commenting on a new dish created from the remaining few food items found in the family's fridge or whether professional restaurant critics and food journalists award stars or points for the creations of a professional chef.

Aesthetics also play a role, both as a consideration the creator may use during the creative process but also as a quality the audience may consider for their judgment. It is thus interesting to explore how creativity translates into aesthetic quality and how the aesthetic quality of inspirational stimuli may influence culinary creativity. Just imagine two studies that could potentially offer important contributions for practice and theory. The first study could look into the aesthetic differences between Western and Eastern approaches to culinary creativity, considering both the creator and the audience. The second study could look into the potential aesthetic differences that may arise when the creator is a female or male chef.

One useful lens that researchers could use to explore these topics is the antenarrative lens. In a recent conceptual MOS contribution, Stierand et al. (2019) theorized the process of culinary creativity through an antenarrative lens, arguing that 'having an idea' is a contextualized and embodied process that can be regarded as an antenarrative, a kind of prenarrative thought, of the overall creative process. The benefit of this lens is that it can help to tap into the sociomaterial qualities of the creative process, which can potentially offer deeper insights into the social relationality as well as the playfulness of creative work. Play, it is suggested, seems to be vital for building bridges between the more formative and sudden manifestations of the creative act in the kitchen (See Play).

Research and practice need to join forces in the pursuit of unraveling culinary creativity. World-class practitioners like Chef Ferran Adrià and Chef Massimo Bottura seem to understand this and have initiated important and very interesting projects. Ferran Adrià after having closed his world-famous restaurant El Bulli in Roses, Spain, created the El Bulli Foundation. This foundation is currently involved in three projects. The first is called La Bulli Grafia, which is an archive museum that tells the story of El Bulli Restaurant, a story that resulted from creative auditing. The second project is El Bulli 1846, an exhibition lab that intends to study efficiency in innovation by using the exhibits as research tools. The third and perhaps most exciting project is called Sapiens, which is essentially the method invented by El Bulli Foundation to comprehend and evaluate a project to improve efficiency in innovation. Through this project, Ferran Adrià tries to generalize his method of genius creativity.

Massimo Bottura, chef patron of the famous Osteria Francescana in Modena, Italy, founded Food for Soul. This non-profit organization, in collaboration with a wide range of partners, is dedicated to making people aware of the massive problem of food waste and social isolation and to form and foster community kitchens around the world to recycle food. It is not a charity, but a cultural project that builds these community spaces based on three key principles that they name as quality of ideas, power of beauty, and value of hospitality.

That quality, ideas, and hospitality can bring together people are clear, but what is fascinating to see is that extraordinary practitioners seem to have this deep sensory philosophy, a kind of intuitive wisdom, that tells them that beauty, the stereotypical quality of aesthetics can build bridges between people. The Prince's Foundation has realized the power of beauty too and discovered that when social housing is designed in an aesthetically pleasing way, the buildings require less repair because the tenants seem to take care of them more. What academics can and must learn from these extraordinary practitioners is that they have achieved the top of their game and have shifted the boundaries upwards by allowing not only multi- or interdisciplinary to inform their work but also trans-disciplinarity. That is, they allow the different disciplinary birds to fly freely without a cage.

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Cultural Diversity

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Cultural Diversity

In 2015 an estimate of 244 million individuals in the world were classified as migrants. This represents 3.3% of all of humanity, and a substantial increase since 1970, when the estimate of migrants stood at 2.3% of the world population. In consequence of such unprecedented levels of international mobility, cultural diversity and multiculturalism have become one of the key challenges of the modern world. Cultural diversity can be defined as the extent of cultural differences that exist between people. Diversity is most commonly discussed in the context of pan-national, national or ethnic groups that are typically characterized by distinct cultural rituals, values, and languages. However, diversity can also be understood more broadly, in terms of differences in religious affiliation, socioeconomic status or in terms of regional differences (e.g., between Northern and Southern regions of a country). This broad understanding of cultural differences is possible with the acknowledgement that “many forms of culture” exist, and that culture constitutes the expression of the values and traditions of a broad range of distinct social groups, including non-national or non-ethnic groups. Drawing on this distinction our article will focus on experiences of cultural diversity understood in a narrower sense (as experiences of multiculturalism, dual identities, or of working in an international environment) but with reference to other, related forms of diversity: e.g., ethnic diversity, demographic diversity, or “deep level”, informational diversity studied in the context of firms and organizations.

The main chunk of this article will consider the influence that diversity has on creative processes. The diversity-creativity link has been examined across many levels of human experience. For instance, while country-level comparisons focused on the disproportionate numbers of first- and second-generation immigrants among Nobel Prize Winners, studies in organizational behaviour attempted to identify which “types” of diversity are most beneficial for divergent thinking, and which ones are most beneficial for idea implementation. In the latter part of the article we’ll discuss issues to do with cross-cultural differences and cross-cultural comparisons, and we’ll consider how varying cultural content (e.g., cultural values) is transferred during cultural exchange. We will also consider the question of cultural fairness and of cultural diversity within creativity research itself, and what consequences these issues may have for cross-cultural comparisons.

Individual Experiences of Cultural Diversity

We begin with a discussion of how individual diversity experiences (i.e., immigration, diversity exposure) link with creative performance and with people’s success at creative achievements. To understand the role that culture and cultural diversity play in individual creativity it’s important to account for both little “c” creativity as well as big “C” Creativity and little “m” multiculturalism as well as big “M” Multiculturalism. Little “c” creativity refers to everyday creative processes and is apparent on testing in the lab or online, using standardized cognitive tasks and psychometric testing tools. Big “C” Creativity refers to the “great person” approach and the achievements of eminent creators and typically relies on archival analyses of great works of art and sciences, and the biographical details of the creators. Due to drastically different methodologies in these two lines of work, the link between “Big C” and “little c” creative outcomes is weakly documented, however reasons exist to believe it exists. Mirroring the “Big C” and “little c” distinction for creativity, a distinction can also be made between long term, immersive experiences of multiculturalism (Big “M”), as well as smaller scale instances of such experiences (little “m”). An integration of both research perspectives is important in order to gain a broader view of the diversity-creativity link. Studies taking the little “m” and little “c” perspective help us understand what processes account for the diversity-creativity link, and can sometimes allow for making causal inferences. Studies of the “Big C” and the “Big M” allow researchers to appreciate how the diversity-creativity link plays out in terms of meaningful creative and innovative outcomes for individuals, groups, as well on a larger, societal scale.

Big “C” Creativity

Several researchers have noted that immigration and biculturalism are linked to a greater success at creative achievements. According to Simonton’s seminal historiometric analyses (Simonton, 1997), throughout Japanese history variation in the degree to which the country was open or not to foreign influences predicted eminent creativity in later generations. Another line of work studied the biographies of 20th century eminent personalities and uncovered that one-fifth of the analysed creators were either first- or second-generation immigrants. In further support of the diversity-creativity link, macroeconomic data from the US over a 10-year period (2000–10) indicated that foreign-born immigrants stimulated economic growth with their disproportionate degrees of eminent creativity and innovation. For instance although foreign-born immigrants represented only 13% of the US population, they accounted for 30% of all the patents granted, and for 25% of all the US Nobel Laureates.

Much theorizing and research has focussed on how the diversity-creativity link driven by immigrants’ individual contributions. For instance Godart et al. (2015) conducted archival analyses of the lives of great fashion designers and uncovered a positive association between these individuals’ multicultural experience, and the creative success of their fashion collections. Godart et al. (2015) distinguished three aspects of multicultural experience: depth (i.e., the extent of immersion in a foreign culture), breadth (i.e., the variety of cultures one was exposed to) and cultural distance (i.e., the extent to which the cultures that one was exposed to were different from one’s original home culture). Their analysis suggested a curvilinear effect in the diversity-creativity link: at lower and moderate levels breadth and cultural distance had a positive link with creativity, however once at a higher level, their link with creativity became null or negative. One explanation of these findings may have to do with saturation effects: perhaps multicultural experiences stimulate creativity at lower levels, but once a sufficient level of stimulation has been achieved, there is no further need for it, leading to a tapering off in the effect. Another reason could be that very high levels of multicultural experience exceed people’s coping ability – too much diversity and multicultural exposure could become overwhelming and threatening to individuals, and this is likely to be exacerbated by a lack of coping resources. In support of the latter idea biographical studies of eminent African-Americans have suggested that minority group membership may enhance creativity, but only in those who remain in good psychological health (Damian and Simonton, 2014).

Little “c” Creativity and Multiple Identities

Cross-sectional research looking at diversity and the “little c” creativity explains what *processes* link multicultural experiences with creative performance. This work theorized that multicultural experiences (e.g., biculturalism, multicultural exposure and cultural diversity) cue people out of schematic thinking patterns, fostering cognitive skills through which multiple perspectives on a problem are acknowledged, learned, and integrated, eventually leading to creative outcomes. Successful acculturation requires that immigrants gain an understanding of and adapt to the values and behaviours prevalent in the host culture. These adaptation processes affect how bi- or multi-cultural identifiers think about the world and their place in it. Membership in one social group or culture allows for smooth operation in line with scripts, norms and values that one has been exposed to in the home and in the family. But as a result of immigration or social mobility, people become members of new groups, which requires them to embrace new cultural values, norms and scripts. Provided that this challenge is successfully addressed, this could lead to the development of more flexible thinking and greater creativity.

Tadmor et al. (2012) conducted a series of studies on how the experiences of bicultural dual identifiers affect these individuals’ performance. In this work dual identifiers, but not immigrants identifying with one culture only, demonstrated higher levels of *integrative complexity*. Integrative complexity entails the ability and willingness to acknowledge and integrate competing perspectives on the same issue. Furthermore, dual group identification was also associated with a greater creativity, innovation in the workplace, and promotion rate at work, and those effects were mediated by increased integrative complexity (Tadmor et al., 2012). Similar observations have been made in bilingualism research. This area may however be problematic, for two reasons. First of all, the robustness of research findings on the cognitive advantages of bilingualism has been called into question in the recent years. Secondly, whether cognitive uplifts observed are due to language developments or second-culture exposure is very hard to establish, as most bicultural individuals tend to be bilingual, and vice-versa. As a result the role of bilingualism in the multiculturalism-creativity link is at present unclear.

Little “c” Creativity and Diversity Exposure

Since the majority of studies described so far have been correlational, it’s hard to judge whether the diversity-creativity link is causal in nature. On the one side it’s possible that multicultural experiences lead to greater creativity, on the other, creative individuals might be predisposed to have more multicultural experiences. Finally, certain personality traits, such as a greater openness to experience, could predispose people to be more creative and simultaneously to be more open to embracing new cultures. The strongest evidence, so far, to a *causal* diversity-creativity link comes from longitudinal research. In a study conducted by Fee et al. (2013) international aid workers from Australia and New Zealand, who were delegated to work in another country, demonstrated an increase in cognitive complexity 12 months following departure (measured against the pre-departure baseline). In a second study cognitive benefits were observed not only relative to ones’ pre-departure score, but also relative to a matched sample of individuals who did not go abroad.

Evidence of a causal link between diversity and creativity can also be inferred from research attempting to simulate the processes that occur during multicultural experiences. For example, [Leung and Chiu \(2010\)](#) invited undergraduates to watch a 45-min-long slideshow that contained various combinations of cultural symbols. After watching images of American and Chinese symbols presented back to back, or pictures representing the American Chinese fusion of cultures (e.g., a rice-burger), participants' responses were more creative, compared with a single-culture (American or Chinese), or a baseline control condition. This "little c" and "little m" research suggests that experiencing a mixing of cultural symbols and norms, which is inherent to the experience of multiculturalism, stimulates greater creativity.

Another line of work focussed on the fact that experiences of multiculturalism and social and cultural diversity challenge people's stereotypic beliefs. In a series of experiments participants were asked to think of counter-stereotypes—targets that violate people's expectations about the traits that they should possess. Thinking of counter-stereotypes led to greater flexibility, the generation of original ideas, and better solutions to insight problems. Notably, the effect was bounded by individual differences in participants' epistemic motivation: exposure to counter-stereotypes lead to greater creativity in people low in the need for structure, however, when need for structure was high, creativity was hampered ([Gocłowska et al., 2014](#)). In a similar vein, research by [Leung and Chiu \(2008\)](#) demonstrated that multicultural experiences increased creativity only when openness to experience was high, but decreased creativity when openness to experience was low ([Leung and Chiu, 2008](#)). Because openness to experience and a (low) need for structure entail people's willingness to engage with things novel and unusual, these traits may regulate the extent to which people are willing to expend resources in the face of cognitively challenging diversity experiences.

Cultural Diversity in Groups

While much psychological research focuses on how social diversity affects individual creativity, a related question is how these processes play out in creative groups and teams. Groups can be diverse in many ways. A corporate team whose members are of different ethnicities, genders or ages is demographically (or "surface") diverse. However, diversity in a group can also be expressed in terms of team members' diverse areas of expertise, their roles in the company, or their different personalities ("deep level" diversity). Furthermore, group and organizational research investigates a very broad range of creativity processes: from idea generation through to innovation processes such as the voicing of or implementation of creative ideas in an organizational setting.

The idea that group-level cultural diversity may enhance creativity can be traced back to Nemeth's work on dissenting opinions ([Nemeth and Kwan, 1987](#)). In a series of studies where a minority of group members (who were really confederates) persistently expressed a dissenting view, the remaining group members were more likely to find innovative solutions, and to generate more original associates. These findings were explained through processes of epistemic motivation: in the presence of dissenting views research participants considered more alternatives and were more open to unusual solutions for fear of coming up with the "wrong" answer ([De Dreu and West, 2001](#)).

Some work supports the idea that these mechanisms can lead to greater creativity in ethnically diverse teams. For instance in the study of [McLeod et al. \(1996\)](#) ethnically diverse (vs. homogenous) groups generated more effective and feasible ideas on a brainstorming task that was relevant to issues of diversity and ethnicity (How to get more tourists to travel to the US?). Another line of work demonstrated that the presence of Black team members in a group task can increase the integrative complexity of essays written by White research participants ([Antonio et al., 2004](#)). Finally, a study by [Vezzali et al. \(2016\)](#) found that when Italian children were asked to work with immigrant children on a cooperative task this led to an increase in individual creativity ([Vezzali et al., 2016](#)).

Notably, the above studies are suggestive of several boundary conditions. Group diversity benefitted creativity on tasks relevant to the topic of diversity, when individuals generated ideas individually (nominal groups), and when differences between group members were deemphasized. Thus, while supportive of the link, these studies revealed that diversity benefits creativity only under a specific set of conditions.

Such a conclusion is further reinforced in management and organizational research. Researchers in these fields argue that out of the various types of organizational diversity, demographic ("surface level") diversity is the *least* likely one to benefit team creativity and innovation. For instance a meta-analysis by [Bell et al. \(2011\)](#) found that while educational, tenure and functional diversity (i.e., differences in experience in various functions in the organization) have a positive relation with team creativity and innovation, gender and ethnic diversity have a small *negative* relationship with team creativity and innovation ([Bell et al., 2011](#)).

Several mechanisms may explain why the diversity-creativity link is rarely observed on the level of group outcomes. First of all, demographic group diversity is most likely to boost performance on a few tasks that benefit from the informational value of this type of diversity. Secondly, effects of group diversity may vary at different stages of the creative process. A third explanation pertains to how ideas from diverse individuals are implemented in team work and team innovation. In spite of their greater levels of integrative complexity or creativity, bicultural or ethnic minority individuals are likely to face barriers during social interaction. Social identity research provides well documented insights on how groups resist influence from minority or non-prototypical group members. As a result diversity is sometimes associated with decreased cooperation, coordination, and cohesion among team members and, ultimately, decreased team performance. Recommendations on how to remedy this do vary, from suggestions that diverse teams should be tasked with idea generation, but not with idea implementation, to calls for the development of more targeted diversity interventions that aim to remove barriers faced by minority individuals.

Cross-Cultural Differences in Creativity

Although much psychological research focuses on ways in which cultural diversity benefits creativity, many have pointed out that creativity research itself is not very diverse. [Leung and Wang \(2015\)](#) have recently analysed creativity-related papers published in top-tier organizational psychology journals (*Journal of Applied Psychology* and the *Academy of Management Journal*) and noted that 70% of papers published there originate from the United States and other Western Countries, with another 20% of samples originating from China. They also noted that most non-Western papers published on the subject of creativity are written from a universalist perspective, not taking into account cross-cultural differences and idiosyncrasies of the culture within which the research had been conducted. This is problematic because of the risk that psychological theories won't be applicable across cultural contexts. Furthermore, vital insights and observations based on non-WEIRD samples (non-Western, Educated, Industrialized, Rich and Democratic) may never be popularized, because they have a relatively low chance of being published in mainstream psychology journals. To address these issues creativity researchers need to consider whether psychological theories that they use are broad enough, whether their participant samples are sufficiently diverse, and whether the psychological tests that they use are culturally fair. This call is also echoed in [Glăveanu's \(2010\)](#) work on the cultural psychology of creativity. [Glăveanu \(2010\)](#) expanded the definition of creativity to "a complex socio-cultural-psychological process that, by working with 'culturally-impregnated' materials within an intersubjective space, leads to the generation of artifacts that are evaluated as new and significant by one or more persons or communities at a given time" (p. 87). Thus, the cultural psychology of creativity suggests that people from different groups might understand creativity differently, and that such cross-cultural differences in the definition of creativity ought to be studied more broadly.

The meaning of creativity differs across national boundaries, with non-Western countries holding a more utilitarian view of creativity and a weaker "art-bias", relative to Western societies. For instance, [Adair and Xiong \(2018\)](#) have demonstrated that Chinese students living in Canada have a more utilitarian view of creativity than Caucasian Canadians, while [Yue et al.'s \(2011\)](#) research showed that Chinese students have more appreciation for the creativity of great inventors or politicians, while German students tend to consider artists and philosophers as highly creative. Further, [Loewenstein and Mueller \(2016\)](#) found that Chinese but not US-American participants judged utilitarian descriptions of products such as "easy to use", "feasible", and "for a mass market" as indicators of creativity. Similarly, [Hanel et al. \(2018\)](#) recently found that Brazilian participants judged professions with a more utilitarian focus such as builder or physician as more creative than British participants.

These findings may be traced back to differences in collectivism and individualism between Western and non-Western countries. Individualism can be understood as an emphasis on the self as independent and agentic, whereas collectivism as an emphasis on a group and one's willingness to sacrifice for it ([Hofstede, 1980](#)). A focus on novelty production is more prevalent in individualist countries such as the US, while a focus on the utilitarian function of creativity is more prevalent in collectivist countries like China (for a more comprehensive review of these differences see [Leung and Wang, 2015](#)).

The individualism-collectivism distinction carries with it not only difference in how creativity is defined, but also differences in performance scores on creativity measures. A host of studies suggest that research participants from Western countries score higher on measures of creativity, compared to research participants from Eastern countries. However, one should also note that other studies show evidence in the contrary direction, both in terms of creative performance as well as differences in lay conceptions of creativity.

Thus, while some studies show that Western students score higher than Asian students on various creative tests, this difference is unstable, and several explanations and caveats should be considered when reviewing these research findings. First of all, the measurement of creativity has predominantly been developed in the USA and according to Western conceptualizations of creativity, and so results of many studies may be biased to capture the view of creativity prevalent on one culture rather than the other. Secondly, discussing collectivism and individualism as an East-West distinction ignores differences that exist between Western countries (e.g., USA vs. Bulgaria), between Eastern countries (e.g., China vs. South Korea), and variability within countries, which, for some variables, such as values, are usually eight to twenty times larger than between-country variability. Third, levels of collectivism and individualism tend to vary across generations as well as social classes, with non-middle class samples responding in more collectivist ways. And finally, the statistical methods used by psychological researchers have been criticised for overemphasizing differences between cultures and countries, and deemphasizing their commonalities.

Summary

In sum, cultural diversity is an important topic of high relevance to the psychology of creativity. Researchers across a range of fields ask about the influence that cultural diversity has on creative performance and innovation potential. Historiometric and experimental work supports the idea that, under the right set of circumstances, individual experiences of diversity can increase people's creative potential. Studies on creativity and innovation in organizational settings are less clear cut, painting a more complex picture and suggesting that although diversity can help groups to generate new ideas, it may also hinder other processes necessary for those ideas to be implemented. Finally, cultural diversity is an important creativity meta-subject, as more needs to be done to make the psychology of creativity diverse, but also to better understand what, in people's conception of creativity and in creative performance, is shared and what is different between cultures.

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D

Dance[☆]

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Dance and Creativity

Dance is a complex and diverse art form. The focus of this chapter is directed towards creativity that is expressed through movement. Ultimately, dance is a form of embodied cognition, including aesthetic and neuroaesthetic embodied perceptions. A brief discussion explores the benefits of dance throughout the lifespan as well as the very real hazards of a typical professional dance career. Whether participating in dance or observing it as an audience member, kinesthetic experiences are shared amongst dancers and their audience. This experience is examined at the physiologic, neurobiological, and perceptual levels in this chapter.

Dance is the oldest form of human artistic expression (Sachs, 1937/1965). In the Hindu religion this is powerfully illustrated; Lord Shiva created heaven and earth while performing the Dance of Creation. All the essential elements of physical existence are evident in dance (Sachs, 1937/1965). It exists simultaneously within time and space, and it always involves the physical body. Even in computer-generated dance, some embodied form or shape is required. In order to be considered a dance, and not just a sequence of movements, intentionality must co-exist with aesthetic appeal (Press and Warburton, 2007). Rhythmic movement patterns and three-dimensional design patterns are physically revealed through the dancer's body. Spatial intention and design elements coexist in the physicalization of dance. These primary factors are the bedrock of dance and they are the key factors identified when assessing creativity in dance (Press and Warburton, 2007).

Throughout the ages dance has appealed to diverse populations. Every individual has an opportunity to dance, whether as an amateur social dancer or a highly trained professional dancer. Today social media incorporates dance as a vehicle to market merchandise, influence fashion trends, or celebrate family or community events. Dance can be witnessed in all settings (i.e., in the end zone when professional football players spontaneously perform a victory dance, in print or media advertising, or in video games). Audience participation estimates are gathered by the National Endowment for the Arts (NEA), however they only estimate attendance at concert dance (excluding commercial dance, social dance, street dance, etc.). According to the 2017 NEA report, 22.8 million adults attended a dance performance. This figure was significantly lower than the 2012 census, where 36.9 million adult American audience members attended a dance performance in a public concert hall. The decrease in adult participation was directly related to a weakened economy. According to the 2017 survey a weakened economy meant that dancers and choreographers continued to produce new works despite reduced paid employment opportunities. They created dances at the same rate without remuneration and with fewer paying audience members.

[☆] *Change History:* June 2019. Paula Thomson updated the text throughout the article.

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Dance and Aesthetics

The term, aesthetics, captures the sensual delight experienced by a viewer of a work of art (Calvo-Merino et al., 2008). Aesthetic appreciation is usually informed by a subjective notion of beauty (Kirsch et al., 2016). This appreciation crosses all cultures and all age groups, and includes a vast array of dance styles and traditions (Calvo-Merino et al., 2008). Regardless if dance is presented in spiritual, social, or performance settings, the aesthetic appeal resides in its dynamic movement quality. It is identified in the temporal and spatial movement patterns of dancers, as well as in the human body, the movements that are generated by the body, and the emotional intention behind the movement and body posturing. Dancers and their audience recognize and share this aesthetic experience.

The field of neuroaesthetics is now moving beyond the visual arts and music and is including dance. Like the other art forms viewers of dance employ complex visual, auditory, and reward neural networks. In addition the perceptual and motor networks are integrated into the aesthetic experience (Kirsch et al., 2016). Specifically, viewers who ranked specific dance movements as aesthetically appealing, engaged bilateral visual and sensorimotor regions of their brains (Calvo-Merino et al., 2008). This response intensified when viewers were familiar with dance or had expertise in dance (Kirsch et al., 2016).

Dance and Embodied Motor Creativity

Creativity involves the convergence of cognition and emotion. These two major mental processes influence the creation of the product and how it is received (Gu et al., 2018). In dance the sensorimotor system is also deeply integrated in the aesthetic experience. Trained dancers readily recognize and appreciate the aesthetic appeal of dance vocabulary. They have an embodied kinesthetic understanding of dance and respond to dance performances more intensely than novices (Kirsch et al., 2016). The positive reward of witnessing or executing dance movements is heightened in trained performers. Likewise trained dancers perceive non-verbal motor actions as a form of cognitive verbal language. While creating or performing they continually and simultaneously engage declarative (verbal) and procedural (non-verbal) memories; in fact dance is often processed as a declarative language (Blasing et al., 2009). Ultimately these cognitive, emotional, and memory systems are part of what could be termed motor “cognition” or embodied cognition. Talented dancers excel in embodied cognition and motor creativity. The complexity of these interactive systems enhances a sense of self and others, increases cross-modal self-recognition, and intensifies embodied integration of linguistic meaning and communication (Jackson and Decety, 2004). Along with these heightened abilities dancers who possess increased motor expertise also demonstrate an increased sensitivity to the affective body movements of others. Their heightened proprioceptive and physiologic awareness of others strengthens their social cognition (Christensen et al., 2016).

Despite the reality that expertise in dance enhances aesthetic appreciation all living species can recognize movement, including its purpose to communicate. Neurobiological networks are entrained to respond and implicitly understand movement communication. Our brains recognize the actions of others and can direct appropriate sensorimotor responses in return (Jackson and Decety, 2004); this is the bedrock of dynamic embodied cognition and it extends to embodied abstract thought such as truth, value, and aesthetics. This is why dance functions as a universal symbolic language; it can express abstract ideas and truths, whether at the most remote abstract level of spatial and temporal design or at the more immediate emotionally expressive or narrative level (Kozioł et al., 2012).

These fundamental concepts underpin the emerging research field of embodied cognition; this field of study regards cognition, even abstract thought, as embodied. Embodied cognition implies a biological memory system that encodes information about internal and external physical competencies, perceptual contexts, and motor responses (Gu et al., 2018). Often embodied cognition operates pre-reflectively; instinctive or intuitive responses are mobilized with incredible precision and accuracy. Interactive multi-modal sensory-motor and emotional processes shape the formation of embodied cognition. It is constructed via the specific body we possess, the physical training we experience, and by the particular context within which embodied cognition is grounded (Borghi and Cimatti, 2010). Individual embodied knowledge enhances understanding about other peoples’ movement and intention and it enhances perceptual understanding about the emotional states operating in others (Jackson and Decety, 2004).

Because dance is inherently an embodied art form audiences are readily able to appreciate dance. They have an innate ability to perceive movement and sense another’s movement as if it occurred within their own body. This is even more intensely experienced when audiences view strong dancers who are able to execute powerful coordinated movement that is layered with expressive intent. The audience responds with visceral focused attention, which includes a heightened awareness of physical sounds that operate outside the musical accompaniment (i.e., sounds of breath and body contact with the floor or other dancers) (Reason et al., 2016). Audience members from all cultures respond to dance; our neurobiological systems allow us to recognize and understand movement as well as the emotional and aesthetic appeal inherent in dance (Calvo-Merino et al., 2008).

Dance Education Across the Lifespan

Dance education, whether formal or informal often begins in early childhood and persists into senior years. In academic settings children, adolescents, and college students are given opportunities to freely explore movement with the intention of creating a dance composition (Hagood and Kahlich, 2007; Press and Warburton, 2007). Compositional principles such as form and content, spatial

and temporal intention, and movement phrases and themes are introduced at all educational levels (Hagood and Kahlich, 2007). Students learn to improvise in order to discover movements that express a specific intention. They are able to reflect on the movement material that is generated, examine how groups are organized to enhance aesthetic appeal and emotional intent, and identify and recognize when a composition is successful or insufficient. This ability to examine choreographic elements and manipulate them to enhance creative expressivity is generally promoted in dance education. Although some students also receive formal technical dance training (i.e., ballet, modern, contemporary, jazz, tap, hip hop), the majority of students engage in dance education courses in order to explore everyday movement and to construct movement compositions that express personal experiences (Press and Warburton, 2007). Like the students, dance educators rely on what they describe as “sensing,” “knowing,” “thinking body-mind,” or “whole self-awareness.” They employ embodied intuition and visceral “knowing” to determine whether the quality of a dance performance or performer is good or poor (Chappell, 2007).

While investigating movement novice and experienced dancers discover that assuming specific body postures facilitates the retrieval of autobiographical memories. Assuming body positions that contain autobiographical memories may intensify the emotional expression of the dance (Dijkstra et al., 2007). Likewise assuming body postures and movement sequences might enhance memory retrieval of previously learned dance repertory (Press and Warburton, 2007). These sensorimotor memory systems are integral to the structured “thinking” that operates during professional dance rehearsals and performances. Over time dancers develop an embodied knowing, a way of perceiving oneself from the inside out. They are aware of feelings, movement, and intentions that inform aesthetic decision-making and guide aesthetic appraisal. This form of embodied knowing has also been described as “felt knowing”; for dancers the body and the mind are indivisible (Chappell, 2007).

In the elderly recent research has demonstrated that engaging in the practice of dance enhances sensory, motor, and cognitive functioning. These positive results are directly associated with the demand to coordinate motor movement, while adhering to rhythmic musical patterns, maintaining spatial orientation and awareness, and dancing with a partner in a group (Coubard et al., 2011). Compared to dance, doing simple fitness exercise has far less benefits for the elderly population. Notably, participating in dance enhances cognitive flexibility and quality of life in the elderly (Coubard et al., 2011). Regardless of age long-term participation in dance enhances sensorimotor functioning, including enhanced connections within the cortico-basal ganglia networks. This provides greater coordination and functional integration (Kozioł et al., 2012). In addition, acquiring some form of dance training at any age promotes heightened sensorimotor and affective experiences while performing or observing dance. An embodied understanding of the aesthetic experience of dance is nurtured (Kirsch et al., 2016).

The Dancer: Career Challenges

Given the reality that the aesthetic quality of dance is deeply intertwined with embodiment, dancers frequently experience body objectification. This is a process that diminishes embodied ownership. Objectification intensifies stereotypes of a dancer’s body, especially the image of thinness. Most dancers and their audiences accept these stereotypes, which increases risk for eating disorders and overtraining (Scoffier-Meriaux, Falzon, Lewton-Brain, Filaire, and d’Arripe-Longueville, 2015). As well, many dancers are perfectionistic. They strive to embody aesthetic ideals and perform with an intensity that often increases risk of injury. Professional dancers experience higher rates of injury than most athletes, with prevalence of injuries ranging from 50% to 97% (Air, 2013). The physical demands of dance also limit career longevity, thus dancers often confront an early career transition. Their creative desire to perform is curtailed. This transition from dance is often extremely challenging. Dancers compared to other artists are more emotional, anxious, obsessive, cautious, and less hardy; although they are also intelligent, cognitively and emotionally flexible, and they demonstrate strong achievement motivation (Marchant-Haycox and Wilson, 1992). Despite multiple challenges dancers value the creative process and embrace opportunities to perform and/or choreograph (Press and Warburton, 2007).

Conclusion

Although dance can exist without music, it is generally integrally related to music. The immediacy of dance makes it a powerful medium; it can unite performers and their audience through an interpersonal connection that is facilitated by activation in multiple neural networks, especially the sensorimotor, action observation, and reward networks. Audiences who observe dance readily experience its aesthetic nature, especially when movement is regarded as both pleasing and difficult (Christensen et al., 2016; Kozioł et al., 2012). Even those with minimal exposure to dance can derive a deeper understanding of social cognition; they have an innate ability to understand the language of movement and the emotional content embedded in movement.

Dance is an art form that has existed since the beginning of time. Regardless of changes historically and culturally, dance prevails. Humans are endowed with the ability to appreciate and be aesthetically moved by dance (Calvo-Merino et al., 2008). Embodied cognition resides at the heart of perceptual awareness and motor communication. Embodied motor creativity drives the formation of new dance works; dancers become experts integrating complex mental imagery to motor patterns in order to enhance aesthetic appeal. Dance is an embodied language capable of expressing the most abstract truths and the most profound emotional experiences. Dance is the mother of all the arts (Sachs, 1937/1965).

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Further Reading

Thomson, P., Jaque, S.V., 2017. *Creativity and the Performing Artist: Behind the Mask*. Elsevier Press, San Diego, CA.

Relevant Websites

American Dance Therapy Association: <https://adta.org/>.
 Dance Magazine: <https://www.dancemagazine.com/>.
 International Association of Dance Medicine and Science: <https://www.iadms.org/>.
 International Symposium of Performance Science: <https://performancescience.org/>.
 National Dance Education Organization: <https://www.ndeo.org/>.

Default Network

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Discovery of the Default Network

One of the major developments in the field of cognitive neuroscience was the discovery of the brain's default network (DN). Like many well-known discoveries throughout history, the DN was discovered by accident. Around the turn of the twentieth century, neuroscientists began to notice a mysterious pattern of activity in brain scans, mostly obtained through positron emission tomography (PET) and functional magnetic resonance imaging (fMRI). These scans showed consistent activation within a set of regions located along the midline of the brain (medial prefrontal cortex and posterior cingulate cortex) as well as bilateral inferior parietal regions (angular gyrus) that emerged when people were simply relaxing in the brain scanner. One of the neuroscientists that documented this curious pattern of activity was Marcus Raichle and his team at Washington University in Saint Louis, including Randy Buckner. At the time, Raichle and many other researchers had been conducting cognitive neuroscience experiments by comparing some "active" task state of interest (e.g., solving math problems) to a "passive" resting-state where no task was administered. This "rest" condition was thought to be an appropriate control condition to compare to the "active" task condition and was largely considered to be a source of random noise in the fMRI signal. The term "default" network (or default mode network) was coined because it was thought to reflect the brain's default metabolic state when not engaged with the external world (Buckner et al., 2008).

Nancy Andreasen—another neuroscientist (and noted creativity researcher) studying the DN at the time—was among the first to suggest that default activity did not reflect a passive and uninteresting state, but rather a highly active state of internal mentation. Andreasen even devised a clever acronym for this state of "REST" (i.e., Random Episodic Silent Thought). Several earlier observations by neuroscientists provided clues about the existence of an intrinsic brain system supporting spontaneous thought. Subsequent neuroimaging tools that could measure cerebral blood flow provided support that the brain is indeed highly active during "passive" or "resting" states, including seminal work by David Ingvar who provided some of the first brain images of what would later be called the DN (Buckner et al., 2008). Ingvar and others speculated about a "hypofrontal" brain state—a phenomenon that remains popular in current theories of creativity—characterized by reduced activation within the frontal lobes in the absence of external task demands and a corresponding increase in spontaneous cognition.

In the mid-1990s, cognitive neuroscientists were questioning the appropriateness of using the "resting state" as a control condition. A common finding across many studies was that the same set of brain regions showed "deactivation" compared to a wide range of goal-directed tasks. (It is important to note that the term "deactivation" is relative to the cognitive task of interest, such as reading, solving math problems, or engaging in a language task.) The pioneering work of Nancy Andreasen, who was interested in understanding the neural basis of autobiographical memory, provided compelling evidence that this control condition was misguided. Indeed, by including a novel control task that did not require rest or memory retrieval, she revealed similar activity within the DN during memory retrieval and at rest compared to the control condition. The common engagement of the same brain regions during memory retrieval and rest strongly suggested that common cognitive processes were engaged—namely, internally-directed and self-referential cognition characteristic of autobiographical memory retrieval. The realization among neuroscientists that the control condition of rest reflected important aspects of human cognition led to a paradigm shift in cognitive neuroscience, and the formalization of the network in a series of landmark papers by Marcus Raichle and colleagues in the early 2000s.

In the past two decades, empirical research on the DN has accelerated exponentially, with investigations examining the network's role in health, disease, and development. One of the major discoveries to follow the initial work came from the study of human memory. As noted above, the DN was implicated in autobiographical memory retrieval; subsequent work confirmed that the DN is reliably engaged during a variety of tasks that require participants to recall detailed episodes from their personal pasts. A critical extension of this research came from patients with lesions to the hippocampus—a DN region that plays a critical role in episodic memory retrieval—who showed difficulties imagining possible future events. This observation by Endel Tulving and colleagues raised the prospect that the same region or network supports both memory and imagination. A series of functional brain imaging studies provided compelling support for this theory: recalling past experiences and imagining possible future experiences showed

a consistent pattern of overlap within the DN. The constructive episodic simulation hypothesis was thus proposed by Daniel Schacter and colleagues: the notion that both episodic memory and future simulation are constructive processes that require one to flexibly recombine episodic details (e.g., people, places, and actions) to reconstruct past experience and construct plausible future experiences.

Memory, Imagination, and Creativity

Having briefly described the DN's discovery, we now turn to a discussion of its potential relevance to creative thought. In recent years the network has been implicated in a diverse range of creative tasks, from imagining new uses for objects (Kuhn et al., 2014) to assessing the aesthetic quality of artwork (Vessel, Starr and Rubin, 2012) to creating new music (Limb and Braun, 2008), poetry (Liu et al., 2015), and visual art (Ellamil et al., 2012). On the one hand, one might expect the DN to play an important role in creative thinking, considering the network's association with cognitive phenomena like self-reflection and mental simulation, which are often considered to be components of creative thought. On the other hand, because the DN is strongly engaged during memory retrieval—and creative thinking is thought to require generating ideas and solutions that transcend knowledge—one might expect the DN to constrain the creative thought process by activating what is already known. Indeed, this apparent paradox captures an active line of inquiry in modern creativity neuroscience that aims to understand how and when the DN contributes to creative cognition.

As discussed, the DN is commonly engaged during both episodic memory retrieval and future imagination tasks, indicating that constructive episodic processes support both remembering and imagining. These constructive operations of the episodic system seem to share some overlap with creative thinking, which is commonly considered to involve the flexible recombination of elements stored in memory. Such elements are often thought to be units of semantic memory (e.g., facts, knowledge, and physical features), but recent behavioral research has begun to show links between creative thinking and episodic memory (i.e., memory for personal past experiences). For example, Schacter and colleagues have found that an episodic specificity induction (ESI)—brief training in recalling a recent event in as much detail as possible—can improve performance on classic tasks of divergent thinking. Indeed, following ESI compared to a control induction, participants generate more ideas (higher fluency) that come from more conceptual categories (higher flexibility; Schacter and Madore, 2016). Notably, ESI does not appear to impact the originality of ideas, suggesting that its benefits are specific to increasing generative processes. These findings point to a greater role of the episodic system in creative thinking than has been previously recognized by creativity research, which has largely focused on semantic memory.

Until recently, neuroimaging research has provided only indirect evidence for the contribution of the episodic system to performance on various creative tasks. Activation of DN regions, such as the posterior cingulate and hippocampus, has been reported in several fMRI studies, ranging from divergent thinking to creative drawing. These studies, however, tend to show widespread activation of many other brain regions when contrasting a complex/creative condition (e.g., musical improvisation) with a simpler/noncreative condition (e.g., recalling melodies). Although informative, the selective involvement of specific cognitive processes such as episodic memory or mental simulation is difficult to discern in such designs.

To examine the neural basis of episodic processing during divergent thinking, a recent fMRI study administered the ESI prior to performance on an alternate uses task (AUT; Madore et al., 2017). Consistent with the behavioral study mentioned above, the authors found that ESI increased the fluency and flexibility of ideas generated in the AUT. This enhanced behavioral effect corresponded to increased activation within the left anterior hippocampus, which is consistently involved in episodic memory and simulation. Further evidence for the involvement of the episodic system comes from a study that directly contrasted neural activation during episodic memory retrieval, future simulation, and divergent thinking (Beatty et al., 2018). Compared to a semantic control condition, a conjunction of all three task conditions revealed common engagement within bilateral hippocampus. Taken together with Madore et al. (2017), these findings offer greater clarity on the cognitive processes associated with default activity during creative tasks, and they lend support to the notion that creative thinking involves the same flexible constructive episodic system as is engaged when one is remembering and imagining.

The DN has also been shown to support cognitive processes relevant for creative expertise, such as mental simulation (Meyer, Herschfield, Waytz, Mildner, & Tamir, 2019). In a series of experiments, Meyer and colleagues examined whether creative experts—in this study, a sample of professional writers, directors, and actors—are characterized by an enhanced ability to vividly simulate 'distal' experiences compared to their relatively less-creative but equally-successful counterparts (e.g., accountants, lawyers, and medical professionals). The authors reasoned that the groups would show comparable levels of 'proximal' simulation performance (e.g., "what will happen next week?") but that creative experts would show superior 'distal' simulation (e.g., "what will happen next century?"). This hypothesis was supported in two experiments: creative experts showed superior distal (but not proximal) simulation (i.e., they produced more vivid and detailed event descriptions). Interestingly, although creative experts and control participants both engaged the same neural mechanism for proximal simulation (the medial prefrontal cortex of the DN), creative experts more strongly engaged a different brain region during distal simulation (the dorsomedial subsystem of the DN). The results of this study suggest that specific DN regions contribute to cognitive processes relevant for domain-specific expertise, including the ability to vividly simulate experiences far-removed from the here and now.

Old and New Ideas

The involvement of the episodic memory system to creative task performance raises questions about idea novelty. That is, when people draw on memory to generate creative ideas, the ideas they come up with could be truly novel—i.e., generated on the spot, for the first time—or they could be simply recalled from memory. Indeed, a popular approach to scoring divergent thinking responses asks people to identify whether their ideas were ‘old’ or ‘new’ (Gilhooly et al., 2007). Behavioral research has provided evidence for the validity of this scoring method, including the finding that ideas labeled as ‘new’ by study participants are rated as more creative by independent raters than ideas labeled as ‘old’ (Benedek et al., 2014). Beyond its utility for creativity research, the old/new scoring approach provides a useful framework for understanding the role of memory retrieval and corresponding brain regions within the DN to creative cognition.

In a series of fMRI experiments, Mathias Benedek and colleagues examined neural correlates of old and new idea generation in the context of the AUT. The first study (Benedek et al., 2014) used a continuous idea generation paradigm during fMRI, where participants freely generated uses for different objects for 1 min at a time; they spoke their ideas out loud in real-time, and an experimenter recorded them so that participants could later label each idea as old or new. Both old and new idea generation were associated with activation of the right hippocampus of the DN, among other regions; new ideas compared to old ideas activated a region within left anterior inferior parietal cortex commonly associated with executive control. This research provided the first evidence that old and new idea production engage a brain region central to episodic processing.

Despite the intriguing findings of Benedek et al. (2014), a key issue regarding old ideas and memory retrieval was not addressed: namely, the distinction between recalling common object uses and recalling original object uses. Recalling common object uses should rely more on semantic memory (e.g., a car tire used for driving a car), whereas recalling original object uses that have been encountered but are not the common uses for the object (e.g., a car tire used as a rope swing) should rely more on episodic memory and corresponding regions with the DN (i.e., remembering a time when one saw a car tire being used as a rope swing). Indeed, in a follow-up study, Benedek and colleagues found that, compared to recalling common object uses, both the production of new ideas *and* the recall of original old ideas activated bilateral parahippocampal and medial prefrontal regions of the MTL and dorsomedial default subsystems, respectively (Benedek et al., 2018).

Despite the seeming importance of memory to creativity, the constraining effects of memory for creative problem solving are well-documented. Functional fixedness, for example, occurs when people have difficulty overcoming salient conceptual knowledge, such as being reminded of object properties in the classic Duncker’s candle problem. From a neuroscientific perspective, one might expect the DN to play a detrimental role in such contexts, in light of its contribution to memory retrieval. That is, although the DN has been shown to support the flexible combination of information stored in memory, the mere activation of specific items or concepts—such as those that are closely associated with a given cue or problem—may act as a source of interference that disrupts remote conceptual combination and idea production.

In a recent fMRI study, Beaty et al. (2017) examined the neural basis of conceptual interference during a verb generation task. Participants were asked to study a series of semantically-related noun and verb pairs (e.g., shoe-walk, phone-talk, hand-touch). The association between the noun and verb pairs was strengthened during a cued recall test, which presented the nouns and asked participants to recall the associated verbs. Then, during fMRI, participants were presented with either studied or unstudied nouns, and asked to “think creatively” to come up with a new verb that could be creatively linked to each noun; here, the studied verbs were expected to act as a source of interference when participants were generating new verbs to creatively relate to the studied nouns, i.e., the memory of the studied verbs should come to mind and impair idea production. At the behavioral level, the results confirmed this hypothesis: verbs generated in response to studied nouns were less semantically distant than verbs generated in response to unstudied nouns. At the neural level, this difference corresponded to increased activation within the posterior DN during the studied-noun condition, indicating that the memory of the studied noun-verb pair interfered with idea production by activating the DN.

Default and Executive Network Interaction

Mounting evidence implicates the DN in a wide range of creative tasks, raising the question of whether default activity alone is sufficient to explain creative thought. Although this brain system has shown activation in tasks ranging from divergent thinking to poetry composition, the findings of Beaty et al. (2017) and others suggest that the DN may not always provide the most original ideas, particularly when it activates memory traces that are decidedly unoriginal. Evidence from a growing number of studies examining how the DN interacts with other brain networks provides some clues as to how and when the DN supports and constrains creative thought. Instead of assessing activation of singular brain regions, these studies assess *functional connectivity*—the co-activation or correlation of multiple brain regions, presumed to reflect shared information processing between brain regions or some action of one brain region on another.

One of the most consistent findings to emerge from functional connectivity studies of creative thinking is an interaction between regions within the DN and regions within the executive control network (ECN). The ECN is also often called the frontoparietal control network because it consists of frontal and parietal brain regions implicated in several aspects of cognitive control, such as inhibiting habitual response tendencies, maintaining items in working memory, and switching between goals or mental sets. Importantly, the ECN tends to work in opposition to the DN: when one network is active, the other network tends to be inactive,

presumably due to their opposing cognitive functions (externally-directed control and internally-directed cognition, respectively). The involvement of the ECN in creative task performance is consistent with behavioral evidence that suggests executive cognitive abilities partly underlie individual differences in divergent thinking. These studies have found that people who are better able to manage and control their thought processes—e.g., people higher in working memory capacity or fluid intelligence—tend to perform better on creative thinking tasks, presumably because they can more effectively navigate unproductive lines of thought, such as when the DN activates unoriginal memory traces.

The notion that the ECN interacts with the DN to inhibit unoriginal ideas has received some support from recent functional connectivity studies. For example, in the creative verb generation study described above, Beaty et al. (2017) also found that, during the interference condition, a DN region showed increased functional connectivity with ECN regions. In other words, when the old memory trace of the studied verb came to mind—potentially reflected in DN activity—it needed to be inhibited for participants to come up with a novel association, and this inhibitory process was likely executed by ECN suppressing DN activity.

Other research suggests that inhibiting unoriginal ideas is not the only cognitive process associated with DN-ECN connectivity. In the episodic induction study of Madore et al. (2017), which reported activation of left anterior hippocampus during divergent thinking following episodic induction, the authors also examined functional connectivity and found that a hippocampal cluster showed increased connectivity with a frontal ECN cluster following the induction. This finding was interpreted to reflect the involvement of a goal-directed memory retrieval strategy promoted by the episodic induction; in other words, the ECN may couple with the hippocampus/DN to facilitate the strategic retrieval and combination of episodic content from memory. Taken together with the semantic interference fMRI study of Beaty et al. (2017), it appears that the DN may be a necessary but not sufficient neural substrate of divergent thought: the DN may require the ECN to manage and direct complex memory retrieval and combinatory processes that do not always guarantee the production of novel and useful ideas on their own.

At the individual level, a growing number of studies have found that creative thinking ability is characterized by stronger functional connections between the DN and ECN (for a review, see Beaty et al., 2019). In one recent paper, the strength of functional connections between DN, ECN, and salience network regions (a network involved in switching between the DN and ECN) was found to reliably predict a person's divergent thinking ability (Beaty et al., 2018a,b). This suggests that more original thinkers can more readily engage brain networks that tend to work in opposition, as well as the corresponding cognitive processes relevant to creative thought.

Conclusion

The brain's default network was a major discovery for cognitive neuroscience. Since its discovery, there has been exponential interest in investigating its role in human cognition, with several studies confirming the network's role in memory and imagination. More recently, the DN has been linked to various aspects of creative thinking, and considerable progress has been made toward understanding how and when the network benefits and constrains creative thought. This work has expanded our conceptualization of the role of memory in creativity, as well as the contribution of cognitive control, which may be required to manage memory-based idea generation processes that alone do not guarantee the production of novel ideas. As a field, the neuroscience of creativity continues to provide a more refined and nuanced understanding of how the human brain generates creative thought. Going forward, the DN is likely to take center stage in this quest to map the creating brain.

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Definitions of Creativity[☆]

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As historical discussions show, scholars have been attempting to define creativity for several thousand years. For example, Ancient Greek writers argued that only poets can be creative, and that creativity must deal solely with imaginary beings and events. Any practical activity was seen as mere artisanship. Earlier ways of conceptualizing creativity have not vanished. Creative individuals are still seen by some writers as the recipients of messages from above, and true creativity is still sometimes thought to be of necessity useless, and thus to have nothing to do with practical or everyday activities. By contrast, in this entry creativity is examined in what Arthur Cropley called a 'down-to-earth' way. It is regarded as a normal aspect of human existence and the purpose of the entry is to bust the myths surrounding the concept of creativity by outlining its cognitive, motivational, personal and social basis.

The Psychological Basis of Creativity

Thinking Processes

In 1950, J. P. Guilford complained that existing tests of intelligence focused mainly on 'convergent thinking' (finding the single best answer to a circumscribed problem). He contrasted this with 'divergent' thinking, which involves generating new, original and unexpected answers. The 1950 article was entitled 'creativity' and, despite the fact that Guilford also stressed the importance of personality and products, creativity quickly came to be associated with divergent thinking. Other researchers have also concentrated on thinking processes: Well-known approaches include 'lateral' thinking, 'janusian' thinking (named after the Roman god Janus, who could look backwards and forwards at the same time), 'homospatial' thinking (ideas from different domains are brought together into the same space), 'biphasic' thinking (in a first phase uninhibited combinations of ideas are produced, which are then evaluated in a second phase), and 'tertiary' thinking (primary process and secondary process thinking in the psychoanalytic

[☆] *Change History:* July 2019. Arthur Cropley updated the text throughout the article.

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sense are combined). Associational theories emphasize the linking of apparently unrelated ideas ('remote associates') or 'bisociation' (linking unconnected fields).

Metacognitive Processes

Generation of effective novelty thus depends on special cognitive processes such as branching out, generating alternatives, recognizing similarities, and making remote linkages. However, acknowledged creative individuals have emphasized the importance in doing this of heuristics such as construction of neural networks or set breaking. The processes may also be guided by, for instance, intuition – sensing that certain approaches offer more promise than others. This is greatly facilitated by possession of rules or guidelines for recognizing blind alleys from the start and avoiding them. Evaluation skills such as mental blueprints of what an effectively novel solution might look like make it possible to see that a particular approach is proving inadequate or to recognize that a solution is at hand. Thus, creative thinking processes are guided by strategies, hunches or rules of thumb – what is commonly called 'metacognition'. These include monitoring progress, redefining the existing line of attack where necessary, being aware of alternative routes, recognizing opportunities, or understanding the costs and benefits associated with possible changes. Kozbelt (2008, p. 232) referred to creative 'wisdom.'

The Paradoxical Personality

A number of writers – such as Hans Eysenck – have emphasized the importance of personality in creativity. Reviews of the relevant research typically list characteristics such as flexibility, openness, sensitivity, autonomy and ego strength. Nonetheless, it has not proved possible to identify a specific personality profile that is typical of all creative people and also distinguishes them as a group from non-creative people. Striking in the discussion is that the personality characteristics regarded as important for creativity are sometimes contradictory: for instance, the creative personality seems to be simultaneously stereotypically masculine (autonomous, self-confident, tough) and yet stereotypically feminine (sensitive, intuitive, responsible). Thus, creativity requires a paradoxical personality characterized by polarities such as openness combined with drive to close incomplete gestalts, acceptance of fantasy combined with maintenance of a strong sense of reality, critical and destructive attitudes together with constructive problem solving, cool neutrality combined with passionate engagement, self-centeredness coexisting with altruism, self-criticism and self-doubt together with self-confidence, and tension and concentration side by side with relaxedness.

Motivation

The generation of novelty requires not only appropriate thinking and personality, but also readiness to diverge, defy conventional opinions, or accept the risk of being wrong. In addition, creative individuals are affected by cognitive motives which derive from recognition of gaps in existing knowledge (incompleteness), a drive to round out recently emerging knowledge (development), and identification of contradictions in accepted knowledge (conflict/discrepancy). Albert Einstein, for instance, indicated that he experienced all three of these motivating forces, but at different times. A widely accepted idea popularized by Teresa Amabile is that creativity is based on intrinsic motivation: the wish to carry out an activity purely for the sake of the activity itself, regardless of external reward. Some researchers report negative effects of extrinsic motivation, to be sure, but others claim positive effects, and still others report mixed effects. Kerrie Unsworth argued that the effects of external vs. internal motivation depend on whether the problem is imposed from outside or is self-discovered.

According to Edward Necka's triad model, there are five classes of creativity motive: instrumental motives, playful motives, intrinsic motives, control motives and expressive motives. In contrast to the emphasis on intrinsic motivation, this approach argues that creativity can be a means to an end, for example a person might write a book in the hope of making money. At one particular time a creative person may be extrinsically motivated, at another intrinsically. The idea of a dynamically changing structure of creativity motivation is supported by the 'evolving systems' approach of Howard Gruber, according to which a creative product emerges as the result of a long process of development of knowledge, emotions and feelings, and goals.

Feelings and Creativity

Research on creativity and mood, such as that of Geir Kaufman, has shown that mood is a precursor to creativity, accompanies it, and results from it. Furthermore, despite the widespread belief that positive mood is necessary for creativity and negative mood is fatal, research indicates that there is a role in creativity for negative mood too. Positive mood facilitates free expression of ideas, but negative mood promotes accuracy and precision. Thus, both generative feelings such as the thrill of the chase when facing a challenge, excited anticipation when generating novelty, or satisfaction after achieving an effectively novel product, but also conserving feelings such as anxiety in the face of uncertainty, frustration when progress is impeded, or disappointment when a product is not validated, play a role in creativity.

The Changing Understanding of Creativity

The Importance of Products

Largely thanks to Paul Torrance, the 1960s were marked by a focus on creativity in education. Discussions in this era were also heavily influenced by humanistic writers such as Carl Rogers, Abraham Maslow, or Rollo May, who emphasized the beneficial effects of creativity on individual well-being, self-fulfillment, and similar factors. Anatoliy Kharkhurin and Charlene Tan pointed out that Eastern understandings of creativity give greater emphasis to authenticity – representation of the person's true inner self. Although humanistic writers recognized that achieving goals is as an important part of self-actualization (i.e. they did not ignore products), discussions of creativity came to be dominated by questions of recognizing and fostering creative thinking (process), and the purpose of fostering creativity came to be seen as promoting psychological health (person). The role of educators was then seen as providing an appropriate environment (press). Writers such as Robert Albert and Arthur Cropley explicitly stated that (at that time) it was too difficult to establish stable, objective criteria of the creativity of products.

However, other writers have emphasized the importance of products. Donald MacKinnon concluded that they are 'the bedrock of all studies of creativity,' while Sharon Bailin labeled efforts to study creativity without reference to products 'misleading' and 'dangerous.' Creative products are not confined to fine art, literature, performing arts, music, and similar artistic/aesthetic domains, but also includes fields such as business, manufacturing, technology, medicine, administration, education, even defense, anti-terrorism and law enforcement. The role of a physical product is particularly obvious in fine art or performing arts, science, engineering, architecture and the like, or in business, where a concrete product is the usual result of creativity, but the 'wrong' product may spell ruin. On the other hand, in some areas, such as mathematics or philosophy, immaterial products such as novel concepts or symbol systems are more usual. The two kinds of product are possible in all fields, and both may be identifiable in most creative achievements, concrete objects being more prominent or dominant in some domains, symbol systems in others.

Creativity is Transferrable

John Baer has argued convincingly that creativity is domain-specific: He concluded that it is more like expertise than like a general abstract mental capacity comparable to intelligence. It involves domain-specific abilities, knowledge, skills and techniques, which differ from domain to domain (See Domains of Creativity). Other findings show that this is true at both a more general and a more specific level. For example, abstract knowledge is perhaps more important in science, technique in music. However, both mathematical creativity and creative writing require mastery of a set of symbols for representing ideas, although the two symbol systems may be different, while the exact knowledge required for research on creativity is different from what is required in botany, although both fields require a knowledge base. Thus, there is specificity in creativity, but generality too. This point of view seems to be supported by the existence of prodigious polymaths who make creative contributions to several fields, some of them differing widely in the specific knowledge and skills they require. Examples are the Nobel laureates Bertrand Russell (creative in domains covering a spectrum ranging from mathematics to literature), Herbert Simon (economics to psychology), and Albert Schweitzer (theology to music) (See Polymaths).

The core idea of transferable creativity is that there are creativity-related thinking strategies, motives, attitudes, and aspects of self-image that play a role in all fields. Phenomena such as openness to the new, willingness to take risks, or flexibility are now increasingly being referred to as 'competencies,' for example by Judith Burton and colleagues. Unlike skills – which are specific to particular tasks and may quickly become outdated – competencies are general personal dispositions that transcend specific locations and specific eras. Epstein et al. (2008, p. 8) identified four core creativity competencies, which they called 'capturing,' 'challenging,' 'broadening,' and 'surrounding.' Slightly reworded for the purposes of this entry, these involve recognizing and seeing the value of novelty, self-confidence and risk-taking, making remote associations, and openness. The idea of transferable creativity is based on the argument that people who have become used to, let us say, trying a new approach, linking ideas from disparate fields or approaching the same idea from different perspectives in one domain will transfer these competencies to other domains.

Creativity Is Not Always Good

Pan Kampylis and Juri Valtanen pointed out that almost all definitions of creativity treat it as inherently good; as Aleinikov (1999, p. 838) put it: 'devoted to human welfare.' Aleinikov called this 'humane creativity,' which is 'helpful,' 'generous,' and 'unselfish,' while other writers such as Howard Gruber and Mark Runco referred to 'moral' creativity'. However, the existence of what Keith James called 'negative' creativity and Robert McLaren referred to as the 'dark side' – creativity that leads to bad results – should not be overlooked. Sometimes the negative results of creativity are accidental or even unforeseeable; for instance, the discovery of germs was hugely beneficial to humankind, but laid the foundation for germ warfare. Even where an undesirable outcome is foreseeable, negative creativity is not necessarily the result of deliberate evil intentions. Some people may even create evil despite generally having benevolent motives, for instance, because they are unable to, unaware of, or unwilling to anticipate the negative consequences of their work, deliberately or unconsciously blinding themselves to it. This may occur, for instance because of a lack of information, fascination with the work, or because they are deceived or coerced by factors like the prospect of money and fame.

However, creativity is also sometimes deliberately misused, for example in advertising, business, entertainment, politics, science and technology, social or work life, crime, war, or terrorism. Most obviously negative, however, is the deliberate application of creativity with the conscious primary intention of doing harm to others – 'malevolent' creativity. Such intentional negative creativity may sometimes be widely applauded, for instance by the victors in war, even though it is devastatingly negative for the losers.

Thus, it is necessary to avoid being carried away by a general euphoria about creativity, and to look at it in a more differentiated way (See Creative Destruction).

Fundamental Issues

Is Simply Being Different Creative?

Shortly after the Second World War, [Morgan \(1953\)](#) concluded that the only constant factor in virtually all discussions of creativity is novelty. However, subsequent discussions made the important point that novelty alone is not sufficient for creativity. It is possible to speak of 'pseudo-creativity,' which is novel only in the sense of nonconformity, lack of discipline, or blind rejection of what already exists. These properties may be observed in many genuinely creative people, and thus be confused with creativity, but they are not actually an inherent part of it. It is also possible to distinguish what can be called 'quasi-creativity.' This has many of the elements of genuine creativity – such as a high level of fantasy – but its connection with reality is tenuous. An example would be the creativity of daydreams. As [Runco and Jaeger \(2012\)](#) pointed out, genuine creativity requires two further elements over and above mere novelty. A product must be relevant to the issue at stake and must offer some kind of genuine solution, i.e., it must be effective. Otherwise every farfetched, outrageous or preposterous idea or every act of nonconformity would, by virtue of being surprising, be creative. Thus, creativity is nowadays widely defined as the production of relevant and effective novelty. What is meant by 'effective' may differ from, let us say, fine art to engineering to business. In the former case, criteria such as beauty may play a decisive role (i.e., form predominates). By contrast, an engineering product – let us say a bridge – must be capable of doing a specific job: Few people would acclaim a bridge that fell down as a triumph of engineering creativity (i.e., function is paramount). Thus, simple deviation from the usual is not enough on its own.

Can Everybody Be Creative?

Creativity involves producing something novel and effective. However, this raises the question for whom a product, process or idea should be new: for all human beings throughout history, for the society or the era of the creator, or for the creator alone? Requiring that products be new in all human history would mean that a person would not be regarded as creative if someone else somewhere else had had the same idea at some time or other. On the other hand, defining creativity in terms of the point of view of the person in question only would mean that total ignorance would guarantee creativity. In fact, the word 'creativity' is used to refer to products ranging from being novel only in the sense that they have recently come into existence, regardless of relevance and effectiveness – such as a child's drawing on what was until a few minutes before a blank piece of paper – all the way to great works that are widely hailed as enlarging human perspectives in some way not previously seen in all history. The former involve everyday creativity, the latter sublime creativity. Even in the case of sublime creativity, it is possible to distinguish between two ways of producing effective surprise: by means of new applications of existing principles ('secondary' or 'minor' creativity) or by development of new principles ('primary' or 'major' creativity).

A more differentiated approach in this connection is the distinction among 'levels' of creativity made by Irving Taylor: 'Expressive spontaneity' requires only the free production of ideas, without regard to their effectiveness or relevance. This has a role in some creativity training procedures such as brainstorming, and may well be helpful in the production of novelty, but may often lead to pseudo- or quasi-creativity and is not sufficient by itself for sublime creativity. 'Technical creativity' requires unusually high levels of special skills or techniques, for instance with words or paints or a musical instrument or other tools. Despite its importance in some creative activities (such as painting or playing music), technical skill is not sufficient as a universal definition of creativity. 'Inventive creativity' involves applying the already known in new ways, 'innovative creativity' requires expanding known principles, while 'emergent creativity' encompasses the development of new principles. As a general but not universal rule, children often show expressive spontaneity, but lack knowledge of a field or skill with tools or special techniques. In this sense they can be said to display creativity, but only in the form of expressive spontaneity.

In the 1970s the idea of creativity in the person who will never achieve anything creative was introduced into the discussion by John Nicholls. In the 1980s, Ruth Richards and colleagues emphasized the importance of 'everyday' creativity. Although they may not produce innovative or emergent creativity, a high proportion of adults engage in the production of (at least for them) new ideas or products, for instance in the course of creative hobbies, or simply in everyday life. Thus, it is certainly possible to speak of creativity as a widely distributed characteristic seen in large numbers of people. However, some creative products have a greater impact than others. [Kaufman and Beghetto \(2009\)](#) developed a terminology for differentiating among different levels of public impact: They referred to 'mini-c' creativity (generation of novelty that is meaningful and effective only for the individual who generates it), 'little-c' creativity (novelty that has an impact upon at least a few other people), 'pro-c' creativity (novelty that has an impact in a field and is recognized and admired in at least that field), and 'Big-C' (novelty with an impact that puts the person generating it into the history books). However, as [Guilford \(1987\)](#) himself pointed out, historically speaking only about two in every million people produce effective novelty with an extraordinarily high impact. The intensive study of Big-C creativity involves learning a great deal, to be sure, but not about very many individuals, and certainly not about schoolchildren, scarcely any of whom are or ever will be included in the two in a million. Thus, a focus on Big-C deflects attention away from the mini- or little-c of the remaining 999,998 people per million.

What Is the Role of Hard Work and Knowledge in Creativity?

James Austin studied the circumstances leading to famous breakthroughs that seemed to come by chance: examples include Charles Goodyear (vulcanization of rubber), Henri Becquerel (radioactivity), and Alexander Fleming (penicillin). Austin distinguished among four sets of circumstances: blind chance (the individual creator plays no role except that of being there at the relevant moment); serendipity (a person active in a field hits upon something novel and effective without actually looking for it); the luck of the diligent (a hardworking person eventually stumbles onto something); self-induced luck (special qualifications of a person—such as knowledge, close attention to detail or willingness to work long hours—create the circumstances for a lucky breakthrough). Case studies suggest that genuinely creative results require a combination of all four kinds of luck, which raises the question of whether it is a matter of luck at all.

In some case studies, acknowledged creators have reported that their creativity came from nowhere: For example, Henry Miller believed that the ideas for his writing came directly from the ‘celestial recording room,’ and Ray Bradbury reported that he received ‘lightning strikes’ from on high that had to be written down immediately. Probably the best known modern popular exponent of the divine origins approach to creativity is Cameron (e.g., 2002, p. 1). She asserted that creativity comes from God and emphasized the importance of ‘spiritual electricity.’ Such reports have encouraged the idea that hard work and knowledge are unnecessary for creativity, or even that the two are incompatible, and has led to the impression in some quarters that simply relaxing or letting ideas flow will lead to creativity. For example, Kawenski (1991, p. 264) reported that her students’ ‘romantic notions led them to believe that creative thinking consisted of just letting their minds waft about dreamily, waiting for the muse to strike them.’ Rothman (2014) argued that: ‘If you’re really creative, really imaginative, you don’t have to make things. You just have to live, observe, think, and feel.’

However, a number of researchers have confirmed the role of knowledge in creativity: The Canadian Intellectual Property Office reported in 2007 that no less than 90% of new patents are improvements of existing patents. What seems to involve serendipity may, in fact, be ‘quasi-serendipity,’ as Cora Díaz de Chumaceiro put it, i.e., finding something you have put a lot of effort into searching for at a moment when you are not consciously searching for it, so that it seems to come from nowhere. In fact, although Carl Hausman maintained that creativity is so novel that it has nothing to do with anything that already exists, the idea that creativity draws from a wellspring of knowledge was already well established prior to the modern era. For instance, in a study of inventors early in the 20th century Edwin Prindle concluded that they work with existing knowledge gained via past experience. More recent writers such as Sharon Bailin have concluded that novelty always arises out of what already exists. John Feldhusen and Donald Treffinger summarized this view by referring to the ‘knowledge base’ of creativity. In general, an apprenticeship of 10–15 years seems to be necessary for acquiring the necessary fund of knowledge and skills, even in the case of famous youthful prodigies such as Mozart, who, it is true, produced creative music in his teens, but started acquiring systematic knowledge of music at the age of four. Herman Simon and William Chase concluded that about 10,000 hours of intensive work in a domain is necessary for eminent creativity. It seems appropriate to adopt a modified version of an aphorism uttered by Thomas Alva Edison: ‘[Creativity] ... is 1% inspiration, 99% perspiration.’

The Danger of Expertise

It should be borne in mind, however, that knowledge is a two-edged sword. Some recent research has looked at the problem that, although working successfully in a field over a long period of time (i.e., acquiring a great deal of knowledge) can provide a knowledge base that can be manipulated to yield effective novelty, it can also produce tunnel vision that narrows thinking and restricts it to the conventional. In the absence of appropriate personal properties such as openness to the spark of inspiration, flexibility, or courage to try the new, the possession of a large fund of knowledge (expertise) can inhibit the production of novelty. Great knowledge is thus both the friend and also the foe of creativity. Colin Martindale described the relationship as curvilinear: Too little knowledge is bad for creativity, but so is too much. In order to achieve effective surprise, experts need to be thoroughly familiar with the contents of their field but capable of seeing these in a new light. Creative experts often show a freshness and openness that is more typical of beginners: Robert and Michele Root-Bernstein described the ‘novice effect,’ which is seen in experts who are able to break out of the straitjacket of their expertise and look at their subject with the openness and freshness of beginners.

Creativity and Intelligence

Early in the post-Guilford era creativity and intelligence were often treated as rivals or competitors. However, convergent and divergent thinking correlate around 0.5, and studies of achievement have shown that, by and large, those students are most successful who display both creativity and intelligence. Research on, for example, engineers rated as creative showed that they display a combination of both creativity and intelligence. Thus, the two are separate but also related. Various conceptualizations of this simultaneous sameness and difference exist (e.g. the threshold theory, the overlapping skills approach, the components model). Liam Hudson concluded that creativity and intelligence are best understood as two contrasting styles for applying a general mental power, while Michael Wallach and Nathan Kogan referred to ‘modes.’ Arthur Cropley specifically argued that creativity is not synonymous with the divergent style or mode, but depends heavily on convergent thinking too. In fact, the essence of practical, productive, down-to-earth creativity lies in combining divergence and convergence. In discussions of organizational creativity, the idea of switching modes or styles is well-established and is described using terms like ‘oscillation,’ ‘dynamic shifting,’ or ‘mental ambidexterity.’

According to the threshold model, a minimum level of intelligence is necessary before creativity is possible. A slight extension is the idea that as intelligence approaches this threshold (corresponding to an IQ of perhaps 130) from below, the possibility of creativity rises, whereas when intelligence lies above the threshold, increases in intelligence have no consequences for creativity (i.e., IQ and creativity are uncorrelated once intelligence is high enough). This view has been expanded by the idea of a 'one way' relationship between creativity and intelligence. Intelligence determines the upper limits of a person's ability to obtain and store information, without actually being itself part of creativity. The degree of creativity depends upon the amount of divergence displayed in the processing of the information made available by intelligence. An approach even more clearly oriented towards information processing is the idea that intelligence involves channel capacity: Creativity arises from flexible and versatile handling of the information delivered by the channel to generate novelty, lack of creativity results from use of this information to yield orthodoxy.

A different way of looking at the issue is the overlapping components approach. For instance, Robert Sternberg identified six 'facets' of creativity: knowledge, insight, intrinsic motivation, the courage of one's convictions, special personal factors such as flexibility and willingness to take risks, and relevance. Some of these facets are shared by intelligence and creativity, with the result that the two are correlated: for instance, as has already been shown, knowledge is indispensable for both a high IQ and also for creativity. Other facets, by contrast, may be favorable for one but not for the other: Flexibility and risk taking may even detract from performance on an IQ test. Insight, which seems to be involved in creativity may be favorable for intelligence without being absolutely necessary. Intrinsic motivation is favorable for the acquisition of knowledge, but it is possible to operate rapidly, accurately, and logically without it, whereas it is believed to be particularly helpful for creativity. To the extent that they share facets, creativity and intelligence are correlated. Summing up, it can be said that creativity and intelligence are neither identical nor completely different (See Intelligence).

Creativity and Problem Solving

Especially in psychology, problem solving is often discussed in cognitive terms or as a special form of information processing. In conventional problem solving, the person solving the problem knows that it exists and understands the nature of the problem, intends to solve it, possesses special knowledge, some or all of which is required to solve the problem, and knows, at least in a general way, what broad form the solution will take. However, creative problem solving is required when one or more of the elements just mentioned (knowledge of the problem, of the means of solution and of the nature of the solution) is missing. In other words, creativity can be involved in problem solving but is not always necessary, while not all problem solutions are creative.

Thus, one way of showing the role of creativity in problem solving is to divide problems according to (a) their degree of definition; (b) the degree of familiarity of the means for solving them; (c) the clarity of the criteria for recognizing solutions. Clearly-defined problems that are solvable by means of standard techniques and for which there are obvious and well-known criteria identifying the solution constitute 'routine' problems. They can often be solved without the help of creativity, although when existing knowledge is applied in settings where it has previously been treated as irrelevant, a certain 'technical' or 'inventive' creativity occurs. By contrast, some ill-defined problems require, in the first instance, becoming aware that there is a problem at all, defining it, working out techniques for solving the problem, and developing criteria for recognizing a solution. Such 'complex,' 'intractable' or 'wicked' problems demand a high level of creativity. It is possible to distinguish between recognizing problems that are already evident in the present organization of available information and are obvious to any qualified observer, discovering hidden problems as a result of an intensive analysis of a situation, and inventing problems that are only apparent after the available information has been reorganized: Michael Mumford and associates refer to processes such as problem construction, information encoding, category selection, category reorganization, and category combination. A number of researchers see discovering or inventing 'good' problems as the vital step in creativity (See Problem Finding and Problem Solving).

State and Phase Models of Creativity

The idea that creative products result from the interaction of intelligent and creative styles of thought raises the question of how this interaction is organized. Some researchers focus on the idea that it involves phases or stages, and the most widely cited phase model is based on the work of Graham Wallas from nearly 100 years ago. Although he initially identified seven phases, it has become customary to speak of a four-phase Wallas model involving Preparation (a person becomes thoroughly familiar with a content area), Incubation (the person churns through this information), Illumination (a solution appears), and Verification (the person tests the solution thrown up in the preceding phases). The phase of Incubation is the subject of particular disagreement among researchers. It is intuitively obvious that creativity requires processing of information. However, Dean Simonton highlighted the disagreement among more recent theorists and researchers about whether such processes involve incremental improvement of an initial solution in a sequential series of orderly steps (more like the conventional idea of intelligence), or are chaotic and more or less random (more like the conventional idea of creativity). The first version of incubation involves 'monotonic' sequential refinement (polishing) of a single preliminary solution, step by step, each step improving the result of the previous step until the final form is reached. The second version involves many possible solutions popping up more or less complete out of the seething cauldron of ideas, until one is recognized as better than the others and survives through a Darwinian process of survival of the fittest.

Resolving the Paradoxes of Creativity

Creative individuals seem to combine apparently contradictory or even incompatible factors including thinking processes (e.g., divergent vs. convergent thinking), personal motivation (e.g., intrinsic vs. extrinsic motivation), and personal feelings (e.g., thrill of the chase vs. fear of failure). Colin Martindale described this as involving moving backwards and forwards between poles, and labeled it 'oscillation.' The phase approach suggests that both poles of the paradoxes are of central importance, but not simultaneously – states and processes like divergent and convergent thinking, intrinsic and extrinsic motivation, thrill of the chase and fear of failure wax and wane in importance depending on what phase of the innovation process is currently active. David and Arthur Cropley developed an expanded phase model, which splits Preparation into Information (cognitive aspect) and Activation (motivational aspect) at the very beginning and adds Communication and Validation (social aspects) at the end. In practical settings the process can be broken off early, for instance when evaluation of the product to date indicates that it is a failure. It can also start part way through, for instance when a person returns to an earlier partially worked out solution. It also function as a kind of spiral in what Melvin Shaw called 'loops'; for example, new information could make it possible to verify a novel solution that had earlier been rejected. Other writers such as Alexander Bain, Hermann Helmholtz, Henri Poincaré, and Jacques Hadamard identified and named stages (see for example [Sawyer et al., 2003](#)), and more recently the father of brainstorming, Alex Osborn, and Dean Simonton have also suggested phase models.

Creativity and Environmental Pressure

The Social Rules of Creativity

Creativity requires doing things differently from the way they are usually done, or even defying the norms of society, what Robert Sternberg and Todd Lubart called 'contrarianism' (although they were writing about giftedness in general, and not specifically creativity). Thus, creativity can be seen as involving a failure to conform to the norms of society. Societies are prepared to tolerate this to a certain degree, which rules can be broken or how large a deviation is accepted varying from society to society and from time to time, as well as according to the age, social position, occupation, and other characteristics of the individual doing the rule breaking. People publicly acclaimed as creative break the rules, but succeed in staying within acceptable limits. If they do not, they are likely to be regarded as eccentric, immoral, mentally disturbed or criminal rather than creative, with the possibility of being criticized, shunned or even locked away.

Research suggests that, as a result of the issues just outlined, creative people often need the support of advocates or facilitators. Some facilitators energize, activate or release creativity in others, without necessarily producing effective novelty themselves. An important function of such people is to offer creative individuals a safe space where they can break the rules without sanctions, as well as to offer them a positive perspective on themselves, for instance the view that their ideas are not crazy but creative. This recognition can help to foster the courage to deviate from what everyone else is doing, among other things by offering an opportunity to test the limits of the acceptable without risk or feelings of guilt. Creativity facilitators can be unsung people, such as a grade school teacher. In mature workers, such as scientists, working in a team may provide contact with facilitators. The groups of which a person is a member, either intimate groups such as the family, more public groups such as friends, or more or less formally defined groups such as experts/critics, colleagues, or employers can also foster creativity by offering a social environment marked by recognition and encouragement (or, of course, hinder or block it by withholding such positive feedback). Some researchers regard exposure to social support in a supportive (congenial) environment as the crucial factor in the emergence of creativity (See Friendships and Social Networks).

Socio-Cultural Validation

To have an effect or be recognized as creative, a product must thus not only be novel, but must also be communicated to other people and, most important in the present context, be accepted or at least tolerated by them. This acceptance involves what Csikszentmihalyi (1996) called 'socio-cultural validation.' According to this view, creativity is not really a property of products or processes at all, but a category of judgment in the minds of observers, often acknowledged experts or specialists. In some areas the rules for applying the label 'creative' are well established, with the result that there is a high level of agreement, not only among judges, but also between experts and members of the public. In other areas, however, there is less agreement, with the result that there are often controversies, for instance over the quality of a painting or a piece of music, the creativity of a new building, or even the acceptability of a novel law-enforcement procedure. Emphasis on acceptance by observers not only stresses communication, but also defines the final step in the emergence of a creative product: validation by the surrounding environment.

Innovation and Creativity

In the relevant psychological literature on creativity in business and industry the emphasis is mostly on innovation, rather than creativity. The difference is that innovation requires not only creating novelty, but also putting it into concrete practice in a particular setting. Thus, in a certain sense, creativity can be seen as a prerequisite for innovation or as a stage or phase of innovation. Several definitional problems are easy to solve in the framework of innovation, for instance the question for whom novelty should be surprising, relevant and effective, or the issue of chance. Innovation requires the deliberate introduction of ideas, products,

production and marketing processes, and the like, that are novel for a work group or an organization into which they are introduced. Usefulness in the sense of innovation is often easy to judge: production rises, sales improve, costs sink, absenteeism or staff turnover falls, or accidents in the workplace occur less frequently, to give some concrete examples.

Innovation can also be seen as a process having two phases. In the initial ideational phase ideas emerge that are new for the setting in which they occur. These ideas can be novel in an absolute sense (i.e., involving innovative or emergent creativity), but they need not be: For instance, a manager could make suggestions based on standard practice at a former place of work, novel only in the new workplace. Applying the already known in a new setting constitutes a creative act (inventive creativity), but only involves minor or secondary creativity. After this ideational phase comes the behavioral phase, in which the novel idea is put into practice. Creativity may occur without the behavioral phase, but this phase is essential for innovation; thus, innovation imposes a 'usefulness imperative' on creativity (See Innovation).

Researchers have described aspects of the organization that facilitate or block innovative behavior; among these are freedom to make decisions, support from close colleagues, and facilitating attitudes or other qualities of managers (e.g., leadership style). Inhibiting factors include negative aspects of the organizational climate, negative attitudes and leadership style of superiors, and inhibiting structure of command. In the case of the individual person, innovation often demands not only acquisition of new skills, but also changes in thinking strategies, the organization of knowledge, or ways of evaluating work activities. These can conflict with the norms of a particular setting, with resultant uncertainty or anxiety, and may have consequences for the self-concept. Thus, personal competencies interact with the characteristics of the organization to facilitate or inhibit innovation and to moderate its psychological consequences for the people involved.

Concluding Remarks

A common misunderstanding in psychologically naïve discussions of creativity is that it is an unknowable, indefinable force. In fact, as has been shown above, in modern discussions there is substantial – even if not universal – agreement that it is a psychological characteristic of human beings and not, for instance, a message from higher powers. Admittedly, the precise details of the cognitive, motivational, personal and social components of creativity are still the subject of discussion: For example, is it always good, must it be useful, do creative ideas emerge in a step-by-step linear sequence or do they bubble up from a fermenting cognitive brew, are there cognitive short cuts, is creativity general or specific, are the psychological foundations of creativity the same regardless of the level of public acclaim of products? Nonetheless, the age of ineffable, inscrutable creativity is passing away.

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Developmental Trends in Creative Abilities and Potentials

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Introduction: A Roadmap to Creativity Development

Understanding creativity as it develops is one of the most critical topics for creativity research as new findings can help cultivate the fulfillment of creative potential throughout the lifespan. Synthesizing this line of work is however challenging for at least two reasons. First, as duly noted by [Guilford \(1950\)](#) “creative people differ considerably in performance from time to time” (p. 445). In other words, creative productivity and performance is not expected to develop linearly within individuals. Second, creativity is not a unitary entity and observed trends can greatly vary according to the specific aspects of creative potential accounted for (e.g., divergent thinking vs. trait openness). Further, creative performance depends on the domains, tasks, and even stimuli used to assess creative performance ([Barbot, 2019](#)). These facts reflect the complex and multifaceted nature of creativity established in early conceptualizations and widely supported empirically since then. Therefore, one can expect distinct developmental trajectories and pathways for (1) different aspects of the creative potential accounted for (asynchronicity of development), (2) domains of creative productions or tasks at hand and (3) achievements in real-life creative endeavors.

In a nutshell, there is a common agreement that creativity development is grounded in the development of imagination, as manifested in early years, for example, in the playful pretense behavior of children (e.g., [Russ, 2016](#)). This development continues from early childhood to adulthood, following trends generally marked by discontinuities, such as performance peaks, slumps, and bumps (e.g., [Barbot et al., 2016](#)), followed by a progressive decline towards later age (e.g., [Zhang and Niu, 2013](#)). However, the picture of developmental trends from childhood to adulthood and even to elderly age is quite inconsistent with conflicting findings across studies ([Gralewski et al., 2016](#)). In an attempt to summarize the state of affair on research investigating the developmental trends in creative abilities and potentials, this entry will necessarily oversimplify the complexity of this phenomenon by highlighting the most characterizing features of key developmental periods, ranging from early childhood to elderly age. Concluding remarks will discuss methodological challenges as well as future directions for research on creativity development.

Developmental Trends in Creative Potential: A Snapshot of Key Developmental Stages

Early Childhood: Playing to Be Creative

Although we could trace the roots of creativity development partly in individuals’ genetic makeup and in utero life, it is widely recognized that the early years of life lay the foundation for creative thinking. [Russ \(2016\)](#), among others, stressed the importance of pretend play, as a specific type of play which provides the children with a “vehicle for the expression of many processes that are important in creative production” ([Russ, 2016](#), p. 22). Indeed, similar cognitive and affective processes are engaged in both pretend play and creativity. When children are playing, they use their imagination to make things up and generate ideas. The predictive power of pretend play on creativity has been supported by a few longitudinal studies showing that the quality of fantasy or role-play predicts creativity and facilitates imagination in creative tasks. That said, most studies in this line of work have focused on divergent thinking (DT) as a way to operationalize creative potential. The contribution of pretend play for other important factors of creative potential (e.g., openness to experience) is less known, except for few qualitative accounts focusing on eminent cases (e.g., [Root-Bernstein and Root-Bernstein, 1999](#)) (See Play).

DT has been the main focus of most developmental studies, notably because it can be measured from a very early age, and as a result, most of what we know about the development of creativity comes mainly from insights in DT research. For example, [Bijvoet-van den Berg and Hoicka \(2014\)](#) longitudinally assessed the DT of two-year-old preschool children through exploratory

behaviors involved in non-verbal alternate use tasks. They concluded an overall upward trend in DT development as well as profound individual differences in DT during preschool age, consistent with other findings in this line of work.

Childhood: Bumps and Slumps in Divergent Thinking Development

During childhood, most research attention was paid to temporary declines in creative abilities, known as creativity “slumps” (Torrance, 1968). Even though this discontinuity is acknowledged, much controversy exists with respect to the timing, duration, and domain-specific nature of those episodes of discontinuity. Further, DT remains the most common operationalization of creative potential in creativity slump research, and little is known regarding the development of other resources of the creative potential including non-cognitive factors (Barbot, 2019). In essence, work focused on school years has identified three periods of DT slumps. The first corresponds to the entry into formal schooling, at around age 5 to 7. The second, and surely most popular and controversial one proposed by Torrance was coined the “4th grade slump.” It refers to a temporary decline in DT that was observed in a range of studies, and not observed in a range of others (e.g., Said-Metwaly et al., 2019). Finally, a third period of DT slump was outlined towards the beginning of adolescence around age 12.

An entire volume could be devoted to the DT slump phenomenon, given the large corpus of research investigating it and the striking variability in study findings. However, a recent meta-analysis (Said-Metwaly et al., 2019) has greatly contributed to synthesize this line of work and to yield more definite conclusions with respect to its central controversies. From a pool of 2139 standardized means involving over 40,000 subjects (2nd to 12th grade) across 41 studies, three-level meta-analytic models supported three main findings. First, they confirmed an upward trend in DT performance from 2nd to 12th grades, with evidence of patterns of discontinuity. Second, there was no evidence of general (i.e., mean) fourth-grade slump across studies, but instead, a marked seventh grade slump corresponding to ages 12–13, or the identified third period of slump. Third, whether or not average slumps were observed for fourth and seventh grade periods, moderator analyses showed that variability of results were explained by a range of factors including domain and task considered, intellectual giftedness, gender, or country of origin of the study.

Few studies have also emphasized the limited rank-order stability in creative performance during childhood, with slightly higher rank-order stability estimates as the study samples get older. Together, and despite the overall upward trends outlined above, these results support a profound intra-individual variability in DT development during childhood, with a slightly greater rank-order stability in adolescence compared to childhood.

Adolescence: Specialization of Creativity Interests and the Brain

While children’s creativity may be mainly unintentional, during adolescence creativity gets more intentional. Further, creative abilities may become more domain-specific as adolescents develop their interests in particular domains of activities, devote time, and by this means, progressively develop expertise in those chosen ventures (e.g., Barbot et al., 2016). Relatedly, adolescence is also a time in which creative activities invested in childhood may be abandoned, whether by loss of interest in those activities, or through the influence of negative performance feedback (i.e., “mortification” of creativity; Beghetto, 2014). This idea has important bearings with respect to creativity development, because it outlines that, through their new interests, adolescents can actively, and purposely, shape the development of their creativity in specific domains or tasks (much in line with Scarr’s theory of development).

In a time of important neurobiological changes, including a pruning mechanism by which commonly used brain connections are strengthened and those that aren’t often used are eliminated, it is expected that the adolescent’s commitment to specific creative outlets will translate in a specialization of creative potential in those particular ventures. Consistently, Kleibeuker et al. (2016) linked developmental trajectories of creativity during adolescence to changes in adolescents’ cognitive abilities, processes and underlying brain functions. Across several studies with adolescents and adults monitoring neural activation while completing creative problem solving tasks, Kleibeuker et al. found that adolescents performed better than adults on experimental problems that require exploration, seeking alternative solutions and shifting between representations. In many respects, exploration skills are developmentally relevant in adolescence: one of the fundamental tasks of adolescence is forming an identity, which in many ways, involves an exploratory-DT process of consideration or reconsideration of who one is and wants to be. Relatedly, adolescence may be a critical time to incorporate creativity as part of the definition of oneself (i.e., creative identity; Karwowski and Barbot, 2016), and in turn, to cultivate this important part of the self for the rest of one’s life.

From Early to Late Adulthood: Towards Professional Creativity and Achievements

During early adulthood and adulthood, the development of expertise gains further relevance to potentially produce creative achievements at a professional level (i.e., professional creativity). In short, from initial interests - tracing back to childhood or adolescence up to early adulthood - expertise will be developed, especially when sufficient time-commitment and effort is engaged into a particular creative venture. This hypothesis is supported by an empirical demonstration among eminent composers (Simonton, 2000), which concluded that specialization (in this case, overtraining and overspecialization) or versatility (broad interests and “cross-training” across multiple genre) determine creativity development across the life span (See Composers). This “creative-expertise” hypothesis largely applies to everyday life and professional creativity in the general adult population, given the necessary contribution of domain-based knowledge in most creative pursuits.

Aside from work highlighting the increased relevance of expertise as a key ingredient of creative success in adulthood, there is also a small body of research on the development of DT and other key resources of the creative potential. While different developmental models are proposed for research on DT and creative potential in adulthood, the Peak and Decline Model has received particular attention. It suggests an overall growth of creative potential until one's late 30s until it gradually declines. This is consistent with research such as McCrae and colleagues' showing a curvilinear trend with an increase in scores until about age 40, followed by "systematic maturational declines" (McCrae et al., 1987, p. 136).

Elderly Age: Time to Be Creative!

Studies on creativity in the aging population started in the 1970s, and in this context too, they primarily operationalized creative potential with DT tasks. This body of studies generally indicates a decline in creative potential, consistent with declines that have been documented for most cognitive functions (Zhang and Niu, 2013). Both the speed of information processing or reaction time and the unwillingness to question conventions explain age-related declines in aspects of the creative potential. For example, McCrae et al. (1987) partly attributed the decline in different aspects of DT to reduced response productivity. Other studies showed higher scores on elaboration, integration and originality compared to productivity scores, suggesting that more time may be invested in the elaboration, or quality of responses, at the expense of the quantity of responses.

While declining cognitive functioning may explain some of the decline in DT and other aspects of the creative potential in later age, this age is also associated with the opportunity to invest more time commitment into creative outlets. Thus, lower creative potential could come along with greater creative participation and achievements. Creative participation could also gain relevance in light of its potential therapeutic effects. Research has shown the benefits of creative participation to facilitate aging by, for example, providing a sense of purpose, interactions with others, personal growth, self-acceptance and autonomy (e.g., Flood, 2007) (See Aging).

Conclusion

The snapshot of developmental trends offered in this entry illustrates that creativity does not develop by itself, but has to be cultivated by individual factors (e.g., interests), the social environment (family, workplace, and in particular, the school environment) and culture. The range of factors underlying creativity development makes its outcome difficult to predict. Not only does the developmental asynchronicity of important resources of the creative potential result in a varying "fit" between creative potential and specific task requirements over time, but it also remains uncertain whether individuals will use their creative potential at any point in time, and if they do, what the quantity and quality of their creative outputs will be. As noted by Simonton (2000), "*a work that brings its creator unprecedented acclaim may be followed by an embarrassing fiasco*" (p. 312). Not just because the creative quality of any creative pursuit partly resides in the eye of the beholder, but also because creativity is, by nature, an unstable entity. This instability challenges the assessment of creative potential as it develops. This adds to a longstanding issue in measuring creativity development. In essence, the main challenge is the use of either the same task, or alternate form tasks when measuring creative potential over time. Both approaches lead to undesirable biases complicating the isolation of the "true" level of creativity change over time (Barbot, 2019).

Although research on creativity development gained increased attention over past decades and progress was made with respect to a range of methodological and conceptual issues, it is still challenging to derive definite conclusions regarding developmental patterns of creative potential throughout the lifespan. To advance knowledge on this phenomenon, alternative assessments approaches combined with improved research designs are necessary for future studies that consider the multidimensional and multi-domain nature of creativity as it develops.

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Deviance[☆]

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Glossary

Contrarianism Behavior that is intentionally different or opposite from what others are doing.

Deviance Different from what is typical; differing from the norm.

Eccentricism Tendency toward unusual and sometimes outlandish behavior that may contribute to original thinking or may result from it.

Negative Deviance The behaviors that are different from the norms yet do harm to the development of a group or organization.

Open-Mindedness Tendency to consider all options and tolerate or even appreciate different perspectives.

Positive Deviance The behaviors that are different from the norms yet can still make contributions to the development of a group or organization.

Psychosis Disorder characterized by a loss of contact with reality. Historically, it has also been called madness, insanity, or lunacy.

Tolerance Seeing the value in behaviors or ideas even though they are deviant.

Introduction

The word deviance may elicit various negative images. It may be true that, a deviant is often viewed as someone who is dissenting, bizarre, or in the extreme cases, someone who suffers from mental illness or even poses a threat to others. When viewed statistically, deviance is usually seen as a departure from the mean or another measure of central tendency. Dictionaries also define deviance as the departure from what people normally consider to be acceptable. Taken collectively, different views and literal definitions imply that deviance entails a departure or a difference from prevailing cultural, political, physical, behavioral, emotional, and psychological norms. Deviants are rule-breakers or offenders in our social life. People who dress in black on a hot sunny day, who score very high or low on a test relative to their peers, or who eat all of their food through a straw are all examples of being a deviant. Despite all the negative connotations of deviance, it is also necessary for societal and cultural evolution. In the Darwinian model of natural selection, deviance provides the variation from which adaptive ideas and behaviors are selected. In addition, individuals with a tendency to break rules are more creative. A lack of deviance within a group usually results in poor decision making and problem solving and a group tolerating and accepting deviance is healthy.

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Positive and Negative Deviance

Although deviance is generally defined as the departure from the norms, it can be further categorized into positive and negative deviance. Positive deviance, also termed as constructive deviance, seems more counter-intuitive than negative deviance. It refers to the behaviors that are different from the norms yet can still make contributions to the development of a group or organization. It includes a variety of behaviors, such as taking charge, whistle-blowing, prosocial rule breaking, and counter-role behaviors. These behaviors are mostly ethical. Negative deviance, also termed as destructive deviance, refers to the behaviors that are different from the norms yet do harm to the development of a group or organization. It includes behaviors, such as not following the instructions of the supervisors, intentionally slowing down the work cycle, and committing petty theft. These behaviors are mostly unethical.

Besides the differences in the conceptualizations of the two types of deviance, the motivations behind the two deviances also differ. Positive deviants are engaged in deviant behaviors primarily because they are loyal to the group and committed to the long-term well-being and functioning of the group but are concerned about the opinions or behaviors of others in the group. The deviant behaviors are driven by the hope for better group norms and the improvement of the group.

For example, people who understand the harmful consequences of smoking would be at odds with other group members who are engaged in smoking. However, being deviant in the group aims to help other members understand the harms of smoking, thus benefiting the health of the entire group.

Positive deviant behaviors may also be motivated by moral convictions that people hold. They may express their views that are deviant from those of other group members who make racist or other inappropriate comments because their moral convictions keep them from doing the same. Engaging in positive deviance can also be motivated by the feeling of psychological empowerment. On the other hand, negative deviants are engaged in deviant behaviors because they may be dissatisfied with or angry at the organization and are disinterested in the benefits of the group. The deviant behaviors are driven by the rebellion against others in the same group or even the attempt to sabotage the group or the organization that the group belongs to.

Many factors influence whether a person is engaged in positive or negative deviant behaviors. One factor is individual characteristics, such as personality traits and feelings of group identification. People who are agreeable and conscientious exhibit fewer deviant behaviors. Those with high group identification are more likely to show more positive deviant behaviors than individuals with low group identification. Engagement in deviant behavior is also significantly affected by the environmental or situational factors. For instance, people tend to engage in negative deviant behaviors when the nature of the goal and the means for goal achievement are both malevolent. The forgiving actions of the leaders would increase positive deviant behaviors but decrease negative deviant behaviors. In addition, employees engage in more positive rule-breaking behaviors when they face high problem-solving demands.

There are many differences between positive and negative deviance. While negative deviants are more likely to withdraw in the face of challenges, positive deviants may persist in the efforts of changing the group norms. However, surprisingly, these two types of deviance share common characteristics. The two types of deviance are positively correlated among employees in workplaces. Both are negatively correlated with personality traits of agreeableness and conscientiousness as well as perceived organizational support but positively correlated with negative affectivity, constraints among organizations, and conflicts in individuals' roles.

Deviance and Creativity

Research on the personality correlates of creativity behavior implies a profile of creators that is in many ways similar to the definitions of deviants. They show unconventional behaviors, avoid entrenched ways of thinking, are dissatisfied with the status quo, set their own rules, take risks, reject limits imposed by others, are willing to try new things, and open new experiences and ideas. They seem to have less time to be courteous, often refuse to respect others' opinions, and tend to be critical of others.

Some characteristics of creativity are found to be closely associated with deviance. For example, originality, the most widely acknowledged aspect of creativity, assumes unusualness, uniqueness, or novelty. An original or new idea requires some sort of deviance. When we say someone is unusual in comparison to someone else, this typically means that person is different from a group rather than a single instance. That group represents the norm. You cannot be like the norm and yet unusual, unless you are unusual in one particular way but fit the norm in all others. Deviance is, then, assumed by unusualness, uniqueness, originality, and novelty—and at least one of these is required for creativity, though it may be a necessary but not sufficient condition.

The Scales for Rating the Behavioral Characteristics of Superior Students are often used by teachers to identify students' creativity. Creative students are described as individuals who are uninhibited in expressions of opinion, radical in disagreement, more open to the irrational in him or her self, nonconforming, and not afraid of being different. These behaviors are deviant from the conventional classroom practices and the traditional values of our social norms.

Although people generally value creativity, research on implicit theories of creativity and conventional wisdom both suggest that creative individuals and creative processes test norms, question authority, and push limits. Creative persons explore and often seek out deviance, suggesting that the distinction between creativity and deviance is often blurred and difficult to identify. Given the common connotations of the concept of deviance, it might be worthwhile to recognize the value of deviance (See Personality).

Deviance and Open-Mindedness

Creativity is often defined as a complex construct or syndrome, which implies that more than one trait and ability is involved, such as autonomy, nonconformity, or even deviance. These traits may interact with a person's open-mindedness, a fairly common personality trait of creative individuals. Perhaps creative people, because of their open-mindedness and willingness to consider other ideas and concepts, are more likely to accept the deviance of others (See Big 5 Personality Characteristics).

There is a possible functional connection between open-mindedness and deviance. Individuals may consider unconventional and even deviant thoughts and behaviors because of their open-mindedness. This is a critical notion in several ways. Not only does it help explain the relationship between deviance and creativity, it also suggests that open-mindedness may ensure that open-minded people are more tolerant and perhaps even appreciative of creativity and apparent deviance of other people.

For the same reason, one might expect a kind of Matthew effect found in other areas of creativity research, where those with something (in this case, the right combination of open-mindedness and originality) will obtain and generate even more of it. Perhaps parents who have those traits will model and value them, and thereby raise children who also have them. The tolerance supplied by the traits may subsequently generate increased creativity in others who are raised in the same environment. This may also lead to an increased distance between creative and uncreative individuals. It may also explain why there are expectations for creative persons, such as the stereotypes commonly held about artists and other unambiguously creative individuals and their eccentricities (See Mathew, Pygmalion and Founder Effects).

Deviance and Psychosis

Many distinguished artists, musicians, and writers were diagnosed with some kinds of mental illnesses, Adolf Wolffi, Lord Byron, Virginia Woolf, Edvard Munch, Victor Hugo and Jackson Pollock, to name but a few. Robert Schumann, who is one of the most productive Romantic composers of the 19th century, ended up his life in a mental institution. The world-renowned impressionist artist, Vincent Willem van Gogh, suffered from recurrent bouts of mental illness during the final two years of his life, which at last led to his suicide. This link also holds true for average population. For a group of children with manic-depressive illness, researchers found an unusually high proportion of special ability among them.

Many explanations for the relationship between creativity and psychosis are offered. One is from Hans Eysenck, who suggested that both the capacity for creativity and the tendency toward mental disorder result from the same "overinclusive thinking". It occurs when something that does not belong in one category or concept is included in it. At the extreme, this leads directly to psychotic ideation. The psychotic individual is viewed as out of touch with reality—a deviant, at least in thinking, and often in manifest actions. At other times, overinclusive thinking can allow individuals to find unusual but useful connections among ideas. In this way, it can lead to creative thinking.

Another alternative explanation is rooted in an "inverted-U" shaped relationship between creativity and psychopathology, which suggests that a moderate psychosis results in an increase in creativity while a severe situation may lead to a decrease. When individuals have moderate manic illnesses, the psychopathological symptoms lead to the high arousal of brain activity, which may stimulate people with millions of novel ideas. On the other hand, creativity is seen as a channel to relieve the psychological conflicts and emotional distresses.

The evolutionary hypothesis or Darwinian theory of creativity argues that the link between psychoses and creativity is the consequence of the genetic selection. The genes that are liable to suffer from mental illness become adaptive and are retained in human evolution when they show the positive aspect of creativity. In this sense, creativity is viewed as one type of "compensatory advantages" to psychoses in the gene pools.

However, researchers are still exploring the questions such as what kinds of mental illness are associated with what types of creativity and what kinds of creative people tend to experience psychoses. One of those explorations is from James Kaufman, who used the term "the Sylvia Plath effect" when he found that female poets were more likely to suffer from mental illness than other types of writers.

Deviance and Contrarianism

Creative individuals often choose between working within the old prototype and pursuing a novel but probably unacceptable framework. When they think creatively, they are often more intentional than the section above might imply. Sometimes it is a result of tactics or strategies. One tactic is the contrarian one: the individual ensures that his or her actions are original by intentionally doing what others are not doing. The economic metaphor is "buy low and sell high." This tactic suggests that creative individuals often seek ideas which may be out of fashion but still have potential to gain favor. They do not back down from their unpopular view in face of resistance, and later find an opportunity to sell high those ideas. This strategy works well because it does ensure originality, the most commonly recognized facet of the creativity complex. There are, however, two caveats for the contrarian tactic. One is that contrarianism can be used in a manner that is contrary to creative achievement. The other is that contrarian behavior is not necessarily creative. It will likely appear as deviance and for the same reason, it ensures originality. A contrarian tries to find the margin, tries to be an outlier, and is therefore trying to be a deviant in some sense.

Deviance and Eccentricity

People's antagonism to conventional values and entrenched ways of thinking assumes many forms. Eccentricity is one of them. In everyday life, eccentricity is shown explicitly either by absent-mindedness or weird behaviors, especially on trivial things. This may suggest that those eccentrics are more engaged with their own work but pay scant attention to things other than their devoted domain.

Eccentricity is a type of deviance that is often mistakenly associated with psychosis. While schizophrenia and other mental disorders usually lead to dysfunction, eccentrics tend to function well, albeit in ways that appear strange to most people. In both cases, the concept of freedom—to think and behave as one wishes—is present, but the exercise of personal freedom is less dysfunctional in the eccentric.

Studies of eccentrics tend to report that highly gifted individuals exhibit signs of eccentricity and that eccentrics are often creative. The relationship between eccentricity and creativity is hypothesized to hinge on the fact that individuals exhibiting both tendencies are individualistic and apt to go against established norms. Perhaps the most notable example of eccentric creativity is Albert Einstein, whose behavior was often described as erratic or eccentric (e.g., wearing slippers or pajamas to formal events).

Eccentricity has been found to be a predominantly Western phenomenon. This follows from the emphasis on rugged individualism and privacy rights in the Western world. But the evidence in support of the hypothesized link between eccentricity and creativity is very thin, with some research suggesting that eccentrics are not eminently creative and creative individuals may not necessarily be eccentric.

Deviance and Crime

Throughout history, many creative individuals have spent time in jails. This is not surprising because creativity is often perceived as a form of deviant behavior, which can frighten people and threaten established societal norms. The jail lives of many famous persons are good evidence of the conflict between creativity and conformity. At the extreme, creative people are willing to take risks and are nonconforming and their novel ideas are not in line with traditional, societal norms. It may be that some of these individuals do not fear change and are deviant in thoughts, which allows them to produce creative works and lead them to break social laws as well. A subtle distinction can be made between creators who were jailed because their creative activities were perceived to be threatening (e.g., Socrates, Thomas More, and Galileo) and those who saw a stint in jail as furthering their creative endeavors (e.g., Thoreau, Gandhi, and Martin Luther King, Jr.).

On the other hand, the difference between creativity and crime is hard to identify without referring to the product and press (e.g., the social context). Products that are socially useful can be considered truly creative, otherwise, they are the results of crimes. This is similar to Sternberg's opinion that creativity and intelligence need to be tempered by wisdom. In addition, researchers distinguish "negative creativity" from "malevolent creativity" due to the different intentions of the behaviors. Both are deviants in creativity research and may lead to criminal acts. But the former may not indicate evil-intentioned creativity and may suggest potential benefit for the society. One instance is that a person finds a novel way to enter and change the database of the bank where he is working. He does it not because he wants to destroy the database or steal the information from the bank, but just because he intends to improve the structure of the database. "Malevolent creativity", on the other hand, makes use of creative ideas but leads to deliberate harm to other people or the society as a whole. Some of the examples include creative accounting and creative financing, which imply the abuse of accounting and financial systems for personal benefits. It is also frequently seen in warfare and a striking example is the introduction of poisonous gas to the concentration camps during the World War II.

Over the past decade, the empirical evidence has made a link between creative individuals and prisoners. Some studies found that, like most criminals, creative people tend to be anti-social and creative people and criminals are both more likely to ignore authority and do things in their own way. Other research also showed that creative people and prisoners both share the common characteristic of impulsivity. Russell Eisenman has, however, investigated the creativity of prisoners and found little evidence that convicted criminals are more creative than non-criminals. To the contrary, Eisenman believes that prisoners are generally less creative than non-prisoners, although creative prisoners do exist. Much remains to be scrutinized about the relationship between creativity and crime.

Deviance and Drug Use

Creativity and psychosis are also related through the maladaptive coping strategies such as drug use. At first glance, considerable evidence linking drug use and creativity appears to exist. Many eminently creative individuals, including Ernest Hemingway, Edgar Allan Poe, Tennessee Williams, Jackson Pollock, John Belushi, and Eric Clapton, abused alcohol or other drugs. Potential explanations for the apparent relationship include creative individuals' penchant for risks, the disinhibitive effect of alcohol and other drugs on creativity, and the role of drugs in easing the stresses of the creative life (See Alcohol).

However, a deeper look at the issue raises serious questions about the relationship between drugs and creativity. First, while the deviancy necessary for drug use and creativity is often mentioned as a reason for suspecting a relationship, it is worth noting that the use of many drugs, especially nicotine and alcohol, is quite common and thus not dramatically deviant. Second, much of the

evidence supporting the presence of a positive effect for drug use on creativity is anecdotal in nature. Empirical research generally does not support a strong, positive, causal relationship between creativity and drug use. To the contrary, long-term use of alcohol, marijuana, and other drugs appears to have a negative effect on creativity. Even in studies which partially confirm disinhibiting effects, other factors appear to hinder the degree to which individuals capitalize on the production of disinhibited ideas.

But this does not suggest that creativity does not lead to drug use. Creative success often leads to the amassing of financial resources that increase the ability to obtain drugs. People may turn to drugs to alleviate the many stressors associated with creative activity. A relatively new hypothesis is that people who consider themselves to be creative may experience pressures to conform to social expectations for creative individuals' behavior. For example, a writer may react to stereotypical depictions of the "alcoholic writer"—stereotypes held by society and the other writers in the peer group—by using alcohol more frequently (See Drugs).

Conclusion

Deviance seems to be the only real dark side of creativity. However, the ideas and processes that underlies creativity can be used in many ways. Consider the anecdotes surrounding the lives of creative individuals such as Einstein, Poe, Kafka, Martha Graham, and others mentioned in this entry. Their deviant behavior was frequently considered outlandish or dangerous and threatened to overshadow their creativity. Their deviance was often such that only the most sympathetic friends and family members could tolerate it. Steven Spielberg's mother has observed that if she had known the typical means for dealing with her son's frequently bizarre behavior, the arts would have lost a major creative talent. Instead, she simply tolerated her son's deviant behavior and encouraged his creativity.

The role of deviance in creative individuals and creative work needs to be accepted for social progress. It needs to be tolerated or it will be lost which will result in losing an opportunity to enhance creative work and social progress. Indeed, regardless of the ambiguity of research on creativity and deviance, most researchers voice the same basic conclusion: tolerance for creative ability. More specifically, what is needed is (a) increased tolerance for seemingly deviant behaviors and (b) discretion about when to be deviant and tolerant and when not to be deviant and tolerant. Clearly, both can be taken to inappropriate extremes.

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Dialectical Thinking: Further Implications for Creativity

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Formation, transformation, the eternal Mind's eternal re-creation

Goethe, Faust II, Vs. 6288

Seven Dimensions of Dialectical Thinking

Dialectical thinking starts with the ancient insight that knowledge results from a dynamic process on different levels. First dialectical thinking relies on an ever-changing process: "everything flows." Intellectual progress is based on stable knowledge that is in certain parts deconstructed and synthetically reconstructed in new ways. It employs the interplay of thesis and antithesis in a constructive way to achieve an elaborated synthesis.

Second, dialectical thinking systematically applies traditional knowledge to actual problems. In this process traditional knowledge gains new meaning and is creatively deconstructed. Vice versa, the actual problem-solving processes are enriched and —creatively contextualized.

Third, general principles are applied to individual problems. In this process general principles become a new form and individual problem-solution can achieve general meaning. In this process, the dialectical interplay of individual causes and general principles can lead to new and usable problem-solutions. This process takes place in creative persons as well as in societies. Dialectical thinking synthesizes single ideas with the wholeness of knowledge of the domain. The dialectics of construction and deconstruction lead to new purposeful constructions and take place in an interplay of materiality and spirituality.

Fourth, on a more complex level, theoretical principles are applied to practical problems in the creative process. In this process, theoretical principles can be enhanced and transformed as well as the practical solutions gain general significance.

Fifth, dialectical thinking is a communicative process. Dialectical thinking does not only occur in everyday life and culture but also in science. Even the interpretation of strictly evidence-based knowledge depends primarily on the historical and societal situation. Most prominently Sokrates and Platon showed that insight stems from dialogue. This does not only mean dialogue with the other but also the dialectical interplay of past and present experiences (see Holm-Hadulla, 2004). This fundamentally social nature of dialectic creativity also facilitates new impulses for coaching, counseling, and psychotherapy (Holm-Hadulla, 2017).

Sixth, dialectical thinking can trace dialectical structures in natural sciences, psychology, and cultural studies and mediate these different perspectives interdisciplinarily (Holm-Hadulla, 2013).

Seventh, dialectical thinking can reveal scientific aspects of myths and discover mythic aspects of science.

Background

Dialectical thinking is deeply rooted in our cultural memory. Since ancient times, the interplay of seemingly contradictory propositions and beliefs plays a major role in culture. Dialectics, e.g., between constructive and destructive forces in human striving, can be found in ancient Egypt; old China, such as Konfucianism; and India, for example, in Buddhism. Similarly, the Biblical comprehension of creativity as a constant battle between good and evil forces is a predominant concept in Western culture. From ancient Greek philosophies of Heraclitus, Sokrates, and Plato to the "classical" dialectic theory of Hegel, the seven dimensions of dialectical thinking described above are elaborated again and again (see Holm-Hadulla, 2011).

The most sophisticated account on dialectical thinking in modern philosophy stems from G. F. W. Hegel. Hegel showed that scientific and cultural progress shines forth through a continuous interplay of theses and antitheses that leads to new syntheses. His dialectics are highly regarded in society and politics up until today. In the classical period of European culture, creativity has been seen as a battle of constructive and destructive forces, for example, by the politician, scientist, and poet Goethe. In modernity, pop-stars like Madonna, Amy Winehouse, and Jim Morrison versified about the dialectics between constructive creativity and

destructive aggressivity. A prominent example is the song *Sympathy for the Devil* by the Rolling Stones. It demonstrates that the awareness and transformation of human destructiveness into lyrics, music, and dance is a major creative motivation (see [Holm-Hadulla, 2019](#)). This example illustrates how modern pop-culture also deals with the ancient dialectics of construction and destruction.

The following sections will show how dialectical thinking is not only relevant in cultural studies but also in psychological and neuroscientific concepts of creativity. Drawing on dialectical thinking, they present an interdisciplinary synthesis of cultural experiences and scientific results which leads to practical consequences.

An Interdisciplinary Synthesis of Creative Dialectics

The dialectics of order and chaos can be exemplified by the reciprocity of coherence and incoherence. In different scientific domains, the concept of dialectics carries different meaning. However, these diverse scientific concepts express a common ground which amplifies scientific perspectives through interdisciplinary interpretation. The dialectics between coherence–incoherence, stabilization–destabilization, and construction–deconstruction within cognition, motivation, emotion, and action are corresponding and complementary principles.

As a first step to an interdisciplinary dialogue, essential findings on the creative process of neurobiology, psychology, and cultural studies will be presented. Subsequently, the limitations of the individual scientific approaches and elaboration on corresponding and complementary findings of other scientific disciplines will be highlighted. For this purpose, descriptions of phenomena and guiding principles such as the dialectics of coherence and incoherence, order and chaos, and, phenomenologically speaking, intention and fulfillment ([Husserl, 2001](#)) are necessary. These descriptions are relevant in all sciences, but of different significance based on different theoretical, methodological, and interpretive requirements. In interdisciplinary mediation of the findings and descriptions of the individual sciences, there is a risk of improper use of terms since in every scientific domain these terms have different meanings. Ultimately, interdisciplinary dialogue must be established on its own by courtesy of usable concepts and practical consequences ([Gadamer, 1976](#)).

The premise is that interdisciplinary interpretation of psychological, neurobiological, and cultural findings will enhance understanding of creativity and leads to practical consequences. Focusing on the creative processes of everyday creativity which often are a precondition for extraordinary creativity ([Csikszentmihalyi, 1996](#)), the criteria of novelty and usefulness may serve as a preliminary definition of creativity which is yet to become more concrete in the description and analysis of the creative process ([Runco 2014](#)).

Neurobiology of the Creative Process

This section will attempt to demonstrate that innovative forms manifest themselves in the autopoietic activity of the brain which oscillates dialectically between coherence and incoherence. Furthermore, the argument will be made that the neuronal interplay of coherence and incoherence corresponds to psychological findings and cultural experiences.

In an evolutionary interaction between organism and environment, the brain has developed throughout the history of nature as an organ which establishes and maintains the organismic order by means of its fundamental function of integration. The brain hosts coherent perceptions and interpretations of events as well as meaningful action. Moreover, it supports a dynamic balance between information maintenance and flexible adjustment. Neuronal coherence, also described as “intra- and subcortical connectivity,” is a temporal relation of excitation in the nervous system (for detailed references see [Holm-Hadulla, 2013](#)). Such synchronicity of neuronal activity is likely to be the biological manifestation of lived experience and corresponds with the continuity and discontinuity of the stream of consciousness.

The temporal coordination of neuronal activity between different brain areas, measured, for example, with magnetoencephalography (MEG), is of interest for the understanding of the formation of ideas and the perception of emotions as well as goal-directed actions. The emergence of cortical connectivity—for example, between the hippocampus and prefrontal cortex—correlates with the emergence of coherent mental representations. For the understanding of creativity, it is vital to see how the brain integrates the apparent chaos of disordered emotions and perceptions into coherent impressions. There seems to exist a delicate interplay between stabilization and destabilization of cortical networks.

The lack of sufficient coherent neural networks and weakness of neural connectivity seem to be associated with mental disorders. In schizophrenia, for instance, it has been shown that no circumscribed brain lesion is critical, but rather a distributed impairment that involves the connectivity of different cortical areas. Some authors speak of a disconnection syndrome as a manifestation of disturbed coherence. This conception corresponds with the classical phenomenological view that mental incoherence is a characteristic trait and state in schizophrenic psychosis. In posttraumatic stress disorder and some depressive disorders, neural systems associated with emotions are disconnected from neural systems associated with cognitions. The therapeutic success in these conditions is accompanied with an increase in cognitive–emotional connectivity. This is consistent with the results achieved by cognitive-behavioral psychotherapy and psychodynamic psychotherapy. Different psychotherapeutics concur in their support of cognitive and emotional coherence ([Holm-Hadulla, 2017](#)).

Brain activity in general is characterized by a constant interplay between synchronization and desynchronization of neural activity that appears to be subject to a principle of coherence. The passive and active synthesis of conscious experience drifts toward a coherent association of experiences, for instance, in memory and expectation. Husserl speaks of a dynamic transition of intention

and fulfillment (2001). Basically, perception is not only dependent on sensory input but always corresponds with an empty horizon, for instance, when an individual does not see all sides of a dice at once but still is aware of its entirety. On this account, the synthetic forms of perception are not constituted by structures of mere static receptivity, but dynamic networks in process of formation, dissolution, and reformation. Such processes of construction and deconstruction can also be found on the molecular level.

It has been shown that the function of a cortical default mode and its reciprocal interaction with subordinated neural systems leads to organized coherent large-scale networks. The emergence of spatiotemporal order enables self-referential processing, autobiographical recollection, mind-wandering, and creative thinking. Functional connectivity enables the creation of novel and valuable emotions, cognitions, and actions.

In order to stabilize and adapt, the neural networks are constantly recalibrated. This occurs especially during phases of “random episodic silent thinking” (Andreasen, 2005). Andreasen portrays these phases of an undisturbed default mode of brain activity as particularly relevant for creative thinking. In these phases, traces of memory reorganize themselves and adapt to recently acquired content. This is done by continually changing patterns of activity in search of the most likely or plausible coherent models, up to the moment when the selective search turns into a result. It can be shown that these states, which correspond to psychological “illumination phase” of the creative process, are associated with particular first-person experiences, such as “flow.” Its apparent biological correlate is the activation of reward systems.

It is puzzling, however, why the states of cognitive consistency and emotional satisfaction are short and often will be replaced by new problem-solving processes which provoke dissatisfaction. This dissatisfaction associated with the destabilization of coherence resembles the subjective unease during the incubation phase and the demand to strive for new coherent forms.

As on the cognitive level, the dynamics between coherence and incoherence, and stability and instability also play a major role on the level of emotion and interaction. However, from a neurobiological perspective, it seems that some degree of incoherence favors cognitive and emotional activity. This would in turn correspond to psychological and phenomenological studies showing that a certain degree of emotional destabilization, anxiety, and depressed mood may enhance creative activities.

As a result of our neuroscientific considerations, we propose the following definition of the dialectic creative thinking: Dialectically creative thinking involves the synthesis of sensations in an interplay of coherence and incoherence. This process manifests itself in the dialectics between stabilization and destabilization of temporally synchronized or desynchronized neural networks. Thus, the autopoietic activity of the brain hosts the self-sufficient emergence of innovative forms.

In summary, new ideas are correlated with the emergence of new and coherent neural networks. Neuronal connectivity—especially between excitations localized and controlled in the amygdala, hippocampus, and prefrontal cortex—correlates with coherent feelings, thoughts, and actions. There is, as it were, a constant interplay of top-down and bottom-up regulation which leads to neuronal coherence. The destabilization of neuronal coherence which is often associated with unpleasant feelings reinforces the autopoietic activity of the brain to create and stabilize new neuronal patterns. Of practical significance is the finding that the autopoietic mode of the brain functions better when it is not impaired by permanent sensory input.

From an interdisciplinary perspective the question arises how the neurobiological findings and their interpretation can complement psychological creativity research and cultural knowledge.

Psychology of the Creative Process

Corresponding and complementary to neurobiological findings, the dialectical dynamic between coherence and incoherence is also found in psychological creativity research. Studies from cognitive science show that the dialectics of the creative process bring about gradual transformations and end when sufficient coherence has been achieved (for detailed references see [Holm-Hadulla, 2013](#)).

Developmental psychology describes how the dialectics of the creative process begin in early childhood. Various psychological studies show that creativity is associated with an interplay of seemingly paradoxical factors: Crystalline and fluid intelligence, convergent and divergent thinking, concentrated and freely associative thinking, persistence and flexibility, and openness and self-limitation. One can reinforce creative ideas by disciplined work and chaotic ecstasy, as well as by goal-directed and purposeless activities. Creative surroundings are described as strictly organized and freely disorganized at the same time.

Psychologically, the creative process depends on the following basic requirements: talent, knowledge, motivation, personality, and environment ([Csikszentmihalyi, 1996](#); [Runco, 2014](#)). Fluid intelligence may be a prerequisite of creativity along with specific forms of crystalline intelligence like linguistic, logical-mathematical, musical, bodily kinesthetic, spatial, interpersonal, and intrapersonal.

Talents are realized creatively by acting in a dynamic balance of convergent and divergent cognitions and emotions. These relations are akin to the reciprocity between convergent and divergent thinking. Convergent thinking is defined as focused, concentrated, and goal-directed whereas divergent thinking is less focused, associative, and directionless. These concepts match saliently with the neurobiological concept of the dynamical stabilization and destabilization in neural networks. Psychological analysis locates this dynamic process of the interplay of coherence, incoherence, and novel coherence within everyday creativity as well as extraordinary creativity. The notion of dialectics of construction and deconstruction is a further aspect of this relation: one destabilizes stable knowledge and common patterns of experience in order to create new and useful knowledge and patterns.

The motivation and decision to be creative takes place in the dynamic interaction between stable but no longer sufficiently useful solutions on the one side and the instability which precludes new results on the other side. Amabile (1996) and Csikszentmihalyi (1996) expanded the scope of creativity's prerequisites by different personality traits which apparently are in dialectical interplay: resilience and flexibility, concentration and openness to new experiences, conformism and nonconformism, and stability and tolerance of ambiguity. With respect to the practical creative processes, the dialectics between these factors seem to be an important guideline. Furthermore, the differences in the interaction of the psychological factors in different domains (cf. Runco and Richards, 1997, Runco, 2014) should be taken into account.

In addition to the complex interweaving of talent, knowledge, motivation, and personality traits, environmental conditions play an important role in the creative process. Similar to the neurobiological point of view, the psychological perspective additionally emphasizes the balance of disciplinary structures and free play areas (Runco, 2014). This change begins in early childhood and continues throughout life. "Interested and empathic guiding" is a term for the supportive function of caregivers which reinforces the talents and motivations of children in an emotionally assertive, but also intellectually competent way. Such guidance should strengthen the resilience to tolerate the dynamics of stability and fragility and foster the interplay of coherence and incoherence, and satisfaction and dissatisfaction throughout the creative process. The process requires the continuous balance between convergent learning and divergent playing. In other words, suitable environmental conditions are necessary to give a stable framework for the self-referential search for innovation.

The dynamic of stabilization and destabilization is shaped differently in special phases of the creative process. This dynamic takes place in the five phases of the creative process: preparation, incubation, illumination, realization, and verification (Holm-Hadulla, 2011). In the preparation phase, for some people it is difficult to patiently acquire coherent knowledge and stable skills because they lack tolerance of the uncertainty that they experience when faced with the yet unfinished creative destabilization and transformation of existing coherent knowledge.

The second phase of the creative process, called the incubation phase, can lead to similar difficulties. This phase is characterized by the fact that the task is set aside and left to autopoietic and often unconscious processing. Like the preparation phase, the incubation phase may evoke distress: After the acquisition of knowledge and skills by virtue of complex motivations, the individual anticipates preforms of creative achievements. He or she must now endure a certain degree of destabilization and incoherence. There is a frequent tendency to reduce the stimulating tension by reverting to previous customs or even manipulating the creative tension, for instance, with alcohol and drugs. Therefore, during the incubation phase, a capacity to let intuitions roam without tangible results as well as the patience to find the creative balance of purposeful activity and undirected autopoietic processes are mandatory (Andreasen, 2005).

The metaphoric term "illumination phase" refers to ancient myths and religious ideas as well as philosophical concepts in which creative inspiration is enabled by divine enlightenment. Psychologically, creative illumination rarely occurs as a sudden inspiration, but is usually a complex phenomenon which develops gradually. To capture the new cognitive, emotional, and practical situation, the dialectic between stabilization and destabilization, and convergent disciplined concentration and divergent associative awareness comes into play once more.

In the fourth phase, called the realization phase, the novel and useful forms are elaborated. Besides passion, curiosity, and originality, stability and resilience are required to endure the slow-paced progress of work and the disappointment that, despite illumination, the work yet remains unfinished. While the incubation phase may cause uncertainty through its lack of precise order and form, the realization phase requires one to renounce new ideas and to convergently form the new order as it had been envisaged in the illumination phase. For the sake of practical implementation, it is important to recognize the hazards of the individual phases of the creative process in order to effectively deal with them.

The last phase of the creative process, the verification phase, is of determining influence for the acceptance of the work in society. The properties of the creative product now acquire a special significance. Psychological categories can no longer grasp what is new, appropriate, useful, and unusual about a scientific idea, a poem, a picture, or a song. The fact that creative people often consider their product with destructive doubts and thus prevent new creative processes is a critical factor. Permanent feedback monitors the phases of the creative process. The reactions of others in the verification phase, for instance, shape the motivation to new preparations, the resilience in the incubation and illumination phase, and the productive realization of other works.

At each stage of the creative process, we can recognize the dialectics between coherence and incoherence, stability and instability, and order and chaos. In the preparatory phase, there is a prevalence of patient acquisition of knowledge and skills. Nevertheless, divergent and associative thinking and feeling are not meaningless, even though their meaning primarily relates to psychophysical regeneration.

The incubation phase is characterized by indefinite and incoherent forms, while in the illumination phase a new order and coherence suddenly occurs which may once again be destabilized by different ideas and emotions in the realization phase. Furthermore, the verification phase is a mix of stabilizing recognition and destabilizing (self-) criticism that can be both an incentive and an obstacle for the engagement with further creative processes. Thus, the creative synthesis which is achieved in the dialectic process does not exclude antithesis. On the contrary, actively conceiving multiple opposites and antitheses can enhance the creative process and lead to better results.

Also, in respect to opposing and even chaotic emotions one could hypothesize that eminent creative persons can endure incoherence better than their average fellow humans do. On the other hand, it seems, as Rorty (2001) summarized from an epistemological and practical standpoint, that, just like in their brain and mind, human beings can also tolerate incoherence in their everyday life only for a finite period of time.

Neurobiologically and psychologically it is undisputed that environmental conditions modulate information processing and recombination. However, although developmental and social psychology can explore factors that are conducive to creativity, they are limited in the exploration of complex cultural influences. Thus, to include the complex cultural conditions of creative processes, it is necessary to refer to cultural studies. This is also important because cultural narratives shape the interpretation and practical application of scientific results (Gadamer, 1976).

Cultural Aspects of the Creative Process

Cultural studies show that the destabilization or deconstruction of the usual orders of cognitions and emotions can lead to new knowledge and creative figurations (Assmann, 1995). One can assume that new and useful coherence emerges in a dialectical process between order and chaos. This explanation corresponds to psychological findings about the transformation of cognitive and emotional incoherence into coherence by creative thinking.

This section shows how the dialectics between coherence and incoherence in the creative process appear in cultural studies. Starting with an analysis of myths of creation can determine that dialectics between chaos and cosmos, i.e., “shaped order,” are dominant in classic narratives (see Holm-Hadulla 2011). In Greek mythology the gods are driven by constructive and destructive forces. For example, Kronos, in Latin called Saturnus, is an incarnation of constructive creativity but also of destructiveness. Following this concept, human beings are blessed with and condemned to permanent creative activity to maintain the order against the forces of chaos.

Similar concepts of creativity can be found in the traditional myths of India and China where divine and human creativity is connected with a permanent struggle between constructive and destructive forces. The implicit description of psychological and social relationships by Greek myths of creation had a strong influence on Greek philosophy which has itself continued to be relevant for Western thinking until today (Gadamer, 1976). The prevalent concept is that there exists a fundamental conflict between order and chaos, and stability and instability, which leads to creative activities.

The dialectic concept of creativity was most influentially formulated by Heraclitus, who emphasized that the world is kept in motion by opposing forces which coalesce into new forms breaking up once more into an endless flow. Particularly in the “*Politeia*”, his most extensive work, Plato wrote that education and culture should serve the goal of transforming the chaos of ideas and affects into coherent forms. Furthermore, he asserted that the community is threatened permanently by destructive forces leading to chaos which require constant creatively ordering activities. Struggle between constructively ordering and destructively disorganizing forces is a motif in Aristotle’s work as well. In a dialectic process chaotic energy and matter realize their potential in creatively ordered achievements (see Holm-Hadulla, 2011).

During the Renaissance, eminent artists, scientists, and politicians were regarded as particularly inspired because they bestowed ordered structure on unordered chaos. Creative potentials flourish in a struggle between constructive and destructive powers. Creative activity brings forth exceptional achievements but can also destabilize and lead to melancholy and despair. In the times of Idealism the whole human development was portrayed by aesthetic theories, for example, of Schiller as a creative task. Especially Hegel showed how individual, social, and political potentials are realized in conflicts of contradictory forces and interests. In the “struggle for recognition” the elaboration of conflicting interests leads to creative development, and social and political order. Hegel did not reduce dialectics to an intellectual operation of thesis, antithesis, and synthesis but conceived them as a way to shape human existence. Recognition becomes a central term in human ambition for new and useful forms. Hegel’s concept is consistent with modern developmental psychology showing the fundamental significance of the human need to be seen and receive responses. Even the most introverted creator needs some kind of recognition, at least by himself or herself.

A special elaboration of the psychological aspects of the classical concepts of individual and social self-realization can be found in Goethe who became one of the most influential statesman, scientist, and poet in Europe. In multiple autobiographical texts he described the close interweaving of emotional destabilization and cognitive disorder with creative achievements. His cultural, scientific, and psychological (self-) reflections lead to the complex idea of a permanent “dying and becoming” in the creative and self-therapeutic process. Interestingly, Goethe was not fond of the term “dialectics” but preferred the notion of “polarity” meaning the interplay of light and dark, and good and evil. Similar ideas can be found in the 20th century, for example, in the later works of Freud (e.g., 1920) which emphasized the importance of everyday creative activity that opposes destructive individual and social forces. In this context, the notion of “creative bipolarity” (Holm-Hadulla and Koutsoukou-Argyriaki, 2017) becomes relevant.

When it comes to the concrete social and political conditions of the creative process ethical aspects should also be considered. In 1942, the Austrian-American economist Schumpeter introduced the concept of “creative destruction” into the economic and political discourse on creativity. However, it was primarily instrumentalized as a justification for economically “unrestrained markets.” At the end of the 20th century creativity became a kind of magical phenomenon which should improve individuals and society. In this context, the term “creative class” was coined in order to describe the social circumstances that guide policies, economy, and culture. This view became very popular until the financial crisis of 2007 dampened the optimism of economic creativity and showed the dangerous side of short-lived innovations.

Conclusion

Dialectical thinking shows that real creativity is never destructive; in contrary it is transformation of destructiveness. This can be seen in politics and social life as well in the individual experiences in consulting, coaching, and psychotherapy. Thus the seven dimensions of dialectical thinking described above work together and lead to an enhanced recognition of reality. Productive communicative processes start with the acceptance of change (1) where traditional and learned personal and social concepts become fluid (2). General principles are applied to individual cases while both gain new significance (3). This is reflected in dialectics of theory and practice (4). Dialectical thinking in consulting, coaching, and psychotherapy is a communicative process (5) that can lead to novel and useful constructions of internal and external reality. Dialectical thinking helps to deconstruct dysfunctional meanings and beliefs not only in personal and social life (6). In science, dialectical thinking can detect cultural patterns in the interpretation of empirical results as well as enhancing cultural wisdom by scientific investigations (7). Myths like “selfish genes,” “bliss molecules,” or “love hormones” ought to be reflected dialectically in the dynamics of real life (*Lebenswelt*). Thus, phenomenological and dialectical psychology can provide a foundation for the interpretation of laboratory results (e.g., [Wendt, 2018](#)).

When using dialectical thinking in consulting, coaching, and psychotherapy, cultural differences in the configuration of order and chaos come into play. In Western cultures uniqueness and individuality of the creative act are emphasized; in Eastern cultures collective and repetitive aspects of creative processes stand in the foreground. The first verb of the Bible, “creavit,” denotes an individual and unique act that gives the chaos structured form while the classical Chinese term “zaohua” refers to a collective and continuous process of transformation of the preexisting state in order to control chaos and destructiveness ([Holm-Hadulla, 2011](#)).

Yet, neurobiological and psychological research as well as cultural studies show ubiquitous dialectical processes between construction and deconstruction, and order and chaos. More specifically, the dialectical interplay of crystalline and fluid intelligence, convergent and divergent thinking, and conscious and unconscious imagination plays a major role in the creative process. The description of creative persons by seemingly contradictory attributes coincides with a dynamic and performative conception of personality. Examples include the productive dialectical interplay of discipline and flexibility, and resilience and sensitivity that contributes to creative achievements.

The theoretical insight into the dialectics of creativity is of practical relevance, for instance, in the reciprocity of external stimulation and undisturbed autopoietic activity of the brain. The mind combines creative ideas within a domain that is periodically autonomous from sensory input. This is consistent with psychological findings and cultural studies that show that creative incubation and illumination need knowledge and skills on the one hand and undisturbed realms for free association and playing on the other.

Practically, the insight into the dialectic of coherence and incoherence, stabilization and destabilization, and satisfaction and frustration in the creative process may inspire a creative person to look for synthesis and flow but may also help to facilitate the acceptance of a certain amount of chaos and stress while creatively shaping one’s reality. The acknowledgment of the dialectics of personality traits that are associated with creativity may reinforce “creative bipolarity.” In all creative domains, one aspect of dialectical thinking becomes especially important: Dialectical thinking is a communicative process between past, present, and future in our social lifeworld.

The creative development of the dialectics of construction and destruction is the main task of humankind. One of the greatest advances in modern physics, the discovery of nuclear fission, led to the creation of the atomic bomb, which unfolded an unbelievable potential for destruction. The ecological destruction of the early 21st century is another example of the double face of human creativity. Furthermore, the media has brought free access to international knowledge with the innovation of the Internet, but also a variety of “creative” productions that contribute significantly to violence and (self-) destruction. The individual technologies and sciences by themselves cannot justify the reasonable application of their innovative results and products. A dialectical discourse ethic seems to be necessary to reasonably apply creative achievements in a global world of conflicting interests ([Habermas, 2011](#)).

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Dignity

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Glossary

Effective surprise A part of how creativity can be defined. Creativity always involved originality, but it also requires some effectiveness, and the novelty of the creative idea often means that reactions to a creative idea, because the creative idea is indeed novel and yet effective, is surprise.

Formal effectiveness This is a second kind of effectiveness offered by Bruner. It is a matter of logic and mathematics, and occasionally music. Bruner quoted the mathematician Henri Poincare when discussing this: "creative thinking uses combinations that "reveal to us unsuspected kinships between... facts long known but wrongly believed to be strangers to one another" (p. 5).

Metaphorical effectiveness This is the third kind of effectiveness. It involves connecting domains of experience that were apart. The paradoxes that are often found in creative products may be a result of metaphorical effectiveness.

Novelty One requirement for creativity, though the concept is often labeled originality. They are, then, close to synonyms. At least one, originality or novelty, must be present for something to be creative.

Personal Creativity Creativity which does not depend on cultural or social input and may be original and effective only for the individual. Social recognition is not involved in personal creativity, though it may come later.

Predictive Effectiveness This is one of Jerome Bruner's distinctions in his work on the effectiveness that is required for creativity. This kind of effectiveness occurs when we look back and see the benefits of the creation.

Primary creativity A form of creativity that is largely unrelated to cultural or social inputs. It is personal but may eventually be shared, in which case it becomes social. Primary creativity is used by creators themselves and may be contrasted with secondary creativity which is the creativity of an audience.

Proactive Creativity Creative action that, unlike reactive creativity, need not be expressed. Proactive creativity may be seen in problem finding, which can be contrasted with problem solving.

Secondary Creativity The creativity of an audience when they construct meaning based on a new idea offered by a creator. They are in the audience and thus recipients but must be creative if they are to find meaning in the new idea. It is a different kind of creativity from that used by the creator him- or herself, but it is creative nonetheless.

Self Actualization The highest level of development. It involves spontaneity, self-acceptance, and creativity.

Standard Definition of Creativity A definition which points to two and only two requirements, namely originality and effectiveness. Each of these may be labeled in different ways. Originality may be novelty, for example, and effectiveness may be utility, fit, or relevance.

Utility A requirement for creativity, though not the only one. It is much like *effectiveness* but utility is consistent with the definition used by the United States Patent and Trademark Office (USPTO) which in turn has influenced several theories of creativity.

Introduction

This entry explores a topic that has received very little attention, but at the same time is very important. It explores how creativity is associated with dignity. This is an important topic because dignity is a part of what it means to be human and what it means to be fully alive. Dignity has been associated with high levels of functioning and high levels of maturity, as well. The world would be a better place if every human lived a dignified life.

To begin it is useful to examine the work of a scholar who contributed mightily to creativity studies, namely Jerome Bruner. He is especially well known for his idea about *effective surprise*. This is how he defined creativity—creative things have effective surprise. That idea adds a nice bit to the *standard definition* of creativity which points to originality and effectiveness. Effective surprise is

a good addition to the definition of creativity because very often, when a creative idea is shared with an audience, they are surprised even though the idea is effective. One well known example of this kind of surprise is that of Thomas Henry Huxley who, after first reading Charles Darwin's theory of evolution, claimed, "Why didn't I think of that?"

The advantages of including surprise in the definition of creativity have been detailed by several scholars, most notably Dean Keith Simonton. He drew heavily from the definitions and methods used by the US Patent Office, the rationale being that they had a procedure in place that allowed them to determine if a patent should in fact be awarded. Simonton slightly modified the terms of the USPO method and suggested that creativity be defined in term of *novelty*, *utility*, and *surprise*. The term utility is not far from effectiveness. Simonton explored four implications of this approach to creativity. These involve (1) expertise, (2) comparability, (3) the role of blind variation and selection retention, and (4) differences between objective and subjective evaluations. The last of these is relevant to the present discussion and will be explore below.

Varieties of Effectiveness and the Benefits of Creativity

Bruner's suggestion of adding effective surprise to the definition of creativity is frequently cited, but actually he said much more about effectiveness. The details he offered in this regard should be considered carefully because effectiveness is a broad term and surprisingly difficult to define in a way that applies well to creativity. This is why so many other terms are sometimes used along with or instead of effectiveness. Just above utility was used, but relevance, fit, appropriateness, and usefulness have also been used.

Thus is interesting that Bruner distinguished between several kinds of effectiveness:

Predictive effectiveness occurs when we look back and see the benefits of the creation.

Formal effectiveness is a matter of logic and mathematics, and occasionally in music. Bruner quoted [Poincare \(1913 p. 181\)](#) when discussing this: "creative thinking uses combinations that "reveal to us unsuspected kingships between... facts long known but wrongly believed to be strangers to one another".

Metaphorical effectiveness involves connecting domains of experience that were or appear to be apart (e.g., Santa Maria Alba, with a face showing her as "virgin, strumpet, flirt, daughter, wife, and mother all at the same time"). That example implies that many of the seemingly paradoxical creative products offered in history (e.g., the concept of complementarity) involved metaphorical effectiveness. There are a number of theories of creativity that point to the role of metaphorical thinking as well.

It will come as no surprise that when Bruner was exploring the various kinds of effectiveness that he also offered ideas about the benefits of creativity. After all, creative things are often beneficial when they are effective, or beneficial only because they are effective. The benefits of creativity are diverse and include.

Problem solving
Adaptability and flexibility
Psychological health
Physical health
Innovation
Invention
Learning & growth (across the lifespan!)

That is an impressive list, and it is even more impressive because each of the benefits listed is an umbrella concept. There are specific benefits subsumed under each.

This leads us to a benefit that is not listed above, nor mentioned when the benefits of creativity are itemized by others. Usually lists of benefits follow from the fact that creativity is a kind of effectiveness—it is effective surprise, or, more commonly, effectiveness combined with originality or novelty. Yet there are benefits that do not follow from the definition that includes effectiveness. I am referring to dignity.

Bruner (1962, p. 2) wrote,

There is good reason to inquire about creativity ... A reason beyond practicality ... The reason is the ancient search of the humanist for excellence ... the next creative act may bring [us] to a new dignity.

This may imply a kind of paradox, but paradoxes often play a role in the creative process. This is clear in reviews of ECCENTRICITY, HYPERSPACE, and the MAGIC SYNTHESIS, each of which is tied to creativity elsewhere in this volume. Paradox is also tied to creativity in some personality research ([McMullan, 1976](#); [Csikszentmihalyi, 1996](#)). Csikszentmihalyi, for example reported a large study of highly creative individuals and found many to be simultaneously feminine and masculine, introverted yet extraverted, mature and yet at other times childlike.

The paradox implied by Bruner's view involves the very practical benefits resulting from the effectiveness of creativity, but also less objective benefits of creativity, including dignity.

This is an enormously important point, in part because the objectively practical side of creativity seems to be taking over the field of creative studies. Businesses and advertisers are using creativity whenever possible, for example. Creativity is listed as one of the

most desired characteristics in the workforce (IBM, 2000) and is one of the top three skills predicted to be required in the job market in 2020 (World Economic Forum's [Future of Jobs Report, 2016](#)). Adidas has athletes bragging about their creativity ("create the game") in order to sell shoes, and creativity or something that depends on it is explicit in the advertisements of IBM, Hewlett Packard, Microsoft ("Everywhere, people are using the Microsoft Surface Pro 4 to unleash their creativity"), Nissan ("Innovation that excites"), and even Absolut Vodka ("Fueled by Creativity").

Bruner was not worried about this increased emphasis on what he called the pragmatic side of creativity. Indeed, he had an explanation for how the dignity that is possible with creativity has increased its importance rather than diminishing as its practical side has boomed. He put it this way:

In periods during which man saw himself in the image of God the creation of works *ad maiorem Dei gloriam* ["For the greater glory of God"] could provide a sufficient rationale for the dignity of the artist, the artisan, the creative [person] but in an age whose dominant value is a pragmatic one and whose massive achievement is an intricate technological order, *it is not sufficient to be merely useful* (italics added p. 2)

This takes us to one of several explanations of how creativity is related to dignity. Simply put, a person might be creative because it is practical, but sometimes in life it is not enough to be merely pragmatic. Practicality becomes fundamental, but it does not give meaning to life. To give meaning to life requires something more. Expressing creativity that is not motivated by practical needs may be that "something more."

In this light, creativity can be enormously useful, but that kind of creativity is not necessarily dignified. It is instead a response to a need and often rewarded. This expression creativity might be a solution to a problem, so the creativity is a kind of problem solving. But creativity is not always problem solving. There is problem solving that is uncreative, and creativity may involve self-expression, problem finding, or dignity and thus not be problem solving. You might say that dignified creativity is not a means to an end; but care must be taken. It may be that creativity leads to a personal ends or solves a personal problem. In this light dignified creativity may be a part of PERSONAL CREATIVITY [elsewhere in this volume] and not a social endeavor. That would mean that dignified creativity is practical, but perhaps practical for the individual alone and not in any socially-recognized fashion.

The labels objective creativity and subjective creativity, first proposed by Stein (1953) and later used by Beghetto and Runco (2019), might be used to distinguish between creativity which is effective in the sense that others can see (objective) vs. the creativity that is only personally meaningful (subjective). This is not a hard-and-fast distinction, however, which was why Beghetto and Runco used primary and secondary creativity instead. They described how the latter might actually include both subjective and objective processes.

Shared Dispositions to Be Creative

There are other ways in which creativity can be dignified. To explain, consider the fact that creativity is a reflection of a genetic disposition which is shared by all humans. Yet not everyone uses their creativity. Why not? One reason is social: society prefers conventions and conformity. There is pressure to get along. Another reason is economic, but not in a financial sense, or at least not always. The term economic here is used as a label for the science of resources. Simply put, creativity requires expending resources. People may invest in their creativity (e.g., temporal investments where they develop expertise or work on some original project) and may not invest in other things (e.g., conventional skills) because they are focused on creativity. Everyone could be creative, and most people probably are, once in a while, but for most people the creativity is practical. What of the creativity that is simply an expression of one's potentials? This would be dignified. We all have an inborn capacity. To use it when there is no pragmatic reason and to use it so it does not go to waste can be dignified. It may be that this is what Bruner meant when he wrote, "The artist, the writer, and, to a new degree, the scientist seek an answer in the nature of their acts. They create or seek to create, and this in itself endows the process with dignity ... (p. 2) It may be that Gruber (1993) was also suggesting something like this in his article titled, "Ought implies can implies create." Then again, he was clearly looking at creativity as a "moral imperative," and here creativity is more of a personal, developmental imperative.

The idea that putting effort into fulfilling one's potentials, even when there is no pragmatic reason to do so—and in fact there may be social pressure to conform instead—suggests that the concept of dignified creativity fits with the theory of creativity that emphasizes authenticity. Maslow's (1973) humanistic approach to creativity includes authenticity. He tied authenticity to self-actualization and the fulfillment of potentials. As a matter of fact he eventually concluded that self-actualization, which is the highest level of human development, is inextricable from creativity. I might add that dignity is similarly a reflection of a kind of maturity, in which case there is a syndrome or cluster of related tendencies found among mature individuals, authenticity, dignity, and creativity included. Critically, the word "maturity" used here should not be equated with age. In fact it may be that MacKinnon's (1960) description is more accurate. He described creative individuals in his article on "the highly effective person." Given that this entry started with a review of the bridge between effectiveness and the practical possibilities of creativity, it seems that maturity would avoid confusion that the label effective might create.

The Human Condition

There is yet another way in which creativity can be dignified. Think back to the distinction between problem solving and problem finding used briefly above. The former tends to be reactive. The latter is likely to be proactive rather than reactive. Why might a person be proactive? By definition he or she need not emit the behavior; the behavior is not elicited or required. So why display it? Perhaps because it is the right thing to do, which is not far from what Gruber (1993) meant. His focus was on morality, however, and there is another way to look at this which may not be clearly tied to morals. I am referring to the fact that a person might be proactive because it is the right thing to do, and not because of shared morality but just because of the human condition. People might be mindful, even though they could be mindless instead (Langer, 1989). People need not invest in their own potentials, but they sometimes do—just because those potentials exist. People might just go through life reacting to what is imposed, but they do not need to live this way. They can instead make choices, do things that need not be done but can be done—including working to fulfill one's own potentials. Recall here that we all have the potential to be creative, and it is dignified to fulfill that potential, to behave proactively, to make choices that need not be made, but can, including the choice to live a creative life. For some, this is what brings meaning to life.

Thus, dignity is possible when we create meaning. Or perhaps just because we create, period. We invest in the process of living and we bring something to the Person X Experience transaction so often described in psychology. We are not passive recipients. We do not waste the human potential to create.

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Discovery[☆]

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What Is Discovery?

Discoveries are unexpected surprises that alter how we understand nature and the ways we go about studying it (Kuhn, 1957). Sometimes discoveries result from changes in perspective, so that for Noble laureate Albert Szent-Gyorgyi, "Discovery is seeing what everyone else has seen and thinking what no one else has thought." (Szent-Gyorgyi, 1963, p. 48) Even in the discovery of new phenomena, there is always a concomitant intellectual or theoretical leap. At least a dozen people saw the fogging of photographic plates by radioactive materials before William Roentgen recognized that it was not a problem with the manufacture of the plates, but of something in the laboratory causing the fogging. The search for that cause led to the discovery of x-rays. More than two dozen bacteriologists saw antagonisms between microbes before Alexander Fleming thought to try to isolate the first antibiotics. Even the discovery of a new species of plant compound or star is only interesting or important within the context of broader issues of chemical engineering, pharmacology, taxonomy, evolution, or cosmology. Martin Harwit argued that, "the distinction between mere detection and actual recognition of a new phenomenon is therefore crucial. We may now be detecting many phenomena that we do not recognize." (Harwit, 1981, p. 31) Discovery requires both recognition and interpretation. However, part of this process involves social forces that determine the dominant paradigm and control the latest fads in funding and hiring, and even aesthetic considerations (Edge and Mulkay, 1976). These factors can aid or slow acceptance of discoveries. In sum, the surprise of insight that some investigators identify with discovery is but one temporally distinct phase within a complex process of reshaping our understanding of natural phenomena and the means for investigating them.

Who Discovers

Every discovery to date has been made by a person. In the age of computers, this is not a trivial statement. So far, several computer programs have generated novel proofs of previous conjectures made by human beings, but no computer has yet generated a new and useful problem, hypothesis, or conjecture, let alone observation. As Poincaré once said, logic proves, it does not invent. Whether computers will be able to be programmed to have "imagination" in the future will stand as one of the greatest challenges of artificial intelligence, manifested by a program capable of inventing something novel that it was not programmed to do (the so-called "Lovelace test").

Given that people have made all known discoveries up to the present time, one must ask what characterizes discoverers. Scientific talent appears to be just as asymmetrically distributed in the general population as is, say, musical or artistic talent. While nearly everyone can learn to do an experiment or play an instrument, few have the talent of an Einstein or a Mozart. Recognizing this talent is not a trivial problem. Einstein's potential was certainly overlooked well into his adult years; Darwin displayed no obvious talent for science as a young man; Mendel's work was completely ignored during his lifetime. A few eminent scientists have, however, displayed the same sort of precocity as Mozart. William Bragg, who won the Nobel Prize at the age of 22 is one example. Notably, studies of precocity among scientists, as determined by high standing in Science Talent Search competitions for high school students, shows that while some national winners have gone on to win Nobel prizes, most precocious teenagers do not even go on to pursue science careers (Subotnik et al., 2001). Achievement tests, tests of divergent thinking, and psychological profiles have also failed to identify any significant predictors of who will succeed in science (Root-Bernstein et al., 1993). Some eminent

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scientists (e.g., Nobel laureates Harold Varmus and Hans von Euler-Chelpin) moved into science careers only during or after college, making their talents relatively late blooming.

Factors correlating with eminence in science are of unexpected sorts. One is training with a previously successful discoverer. Nearly all Nobel prize winners have studied with a previous laureate at some time during their schooling or early careers suggesting either that talent recognizes talent, or that some of the “tricks of the trade” can be learned by apprenticeship.

Discoverers are also often highly talented in their avocations, so that a significant proportion of Nobel laureates report that they have faced difficult career decisions between science, one of the arts, and sometimes the law or business as well. A few, such as Desmond Morris, who is a professional painter as well as ethologist, and Aleksandr Borodin, whose musical compositions are better known than his chemistry, managed to carry on joint careers. Whether the correlation between avocational ability and professional eminence is a result of talented scientists being generally talented or a result of avocational skills priming scientific creativity is currently an unresolved issue, but the majority of polymathic scientists state that arts and crafts avocations have identifiable utility for their scientific work (Root-Bernstein et al., 2019). As Nobel laureate Max Planck said in the introduction to his autobiography, “the creative scientists needs an *artistic* imagination” (see Avocations and Polymaths).

Age is also a factor in making discoveries. Young scientists are more likely to make discoveries than older ones and the earlier that a scientist begins independent research, and the earlier she publishes, the greater her probability of long-term recognition. The probability distribution of making a discovery varies by specific discipline, however. The probability peaks at around 25 years of age for mathematicians, 30 for physicists, 35 for chemists, and in the early forties for biologists. As with all statistical distributions, there are, in this case many important exceptions.

Few scientists make even one notable discovery during their careers while a small minority are continuously productive of high-impact research over many decades. The former tend to stay within the field in which they were trained; the latter change fields regularly (Root-Bernstein et al., 1993). Productivity does not predict impact, some of the highest impact scientists, such as Gregor Mendel and Frederick Banting having produced only a few papers. Conversely, some of the most important scientists and inventors produced hundreds of papers or patents, but only a handful have had significant impact. Quality of discoveries or inventions made by an individual is of much greater consequence than the quantity.

A significant number of discoveries have been made by amateurs (see Art/Science, this volume). Amateur astronomers have been responsible for the first sightings of the planet Pluto and of many of the comets that have been named. The farmer Wilson Bentley, known to posterity as “the snowflake man,” provided some of the best data and many of the key concepts in meteorology. And it is worth remembering that Charles Darwin, Mary Leakey, Jane Goodall, Dian Fossey, and many other eminent biologists were amateurs who learned their craft by doing it.

How Discoveries Are Made

Discoveries come about in as many ways as there are discoverers. There are, however, some general strategies that seem to work more often than others (Root-Bernstein, 1989, pp. 407ff). Peter Medawar (1979), a Nobel laureate in Biology, admonished students that if they want to make an important discovery, they must choose a big, important problem. G. P. Thomson, a Nobelist in Physics, noted that there is no correlation between difficulty and importance of a problem. The big ones can be just as easy (or difficult) to solve as the little ones. Neils Bohr, another Physics laureate suggested that the best problems can be found by focusing on paradoxes – the places where theories and observations are non-congruent or contradictory. Nobel Prizewinner Linus Pauling argued that the key to success is to, “have lots of ideas and throw away the bad ones.” To succeed in science, you must dare; and to dare, you must be willing to fail.

Error itself is a frequent source of discoveries. Every discoverer of note has made errors from Newton and Vesalius to Einstein, Crick and Watson. What distinguishes the discoverer from the forgotten scientist is that the discoverer usually recognizes in his own errors the seeds of new possibilities. Thus, Karl Popper maintained that hypotheses and theories can only be disproven, but never verified, so that all progress comes from identifying where our knowledge fails. Instead of searching for data to confirm preconceived hypothesis, scientists should instead search for data that can *disprove* their hypothesis.

However, not all philosophers of science or working scientists believe that it is any more possible to disprove hypotheses than to prove them. Thus, many scientists advocate some version of Chamberlin’s “method of multiple working hypotheses” (Elliot, 2007). Chamberlin argued that existing data should be used to generate as many plausible explanations as possible and the differences between these explanations subjected to comparative tests. Scientists utilizing this method are very explicit that the “winner” of this competition is not necessarily “right”, but merely the best explanation of available evidence.

The recognition of anomalies is another fecund source of discoveries (Kuhn, 1962). Anomalies are data that contradict theoretical expectation. Sometimes anomalies indicate the limitations of the theory; sometimes they point to a phenomenon that has previously been missed. For example, the discovery of the element argon resulted from the observation that nitrogen prepared from the air is heavier volume for volume than that prepared from chemical compounds. Lord Rayleigh discovered that atmospheric nitrogen is “contaminated” with an unsuspected element called argon, which, because it is non-reactive, accumulates in air but is not found in chemical compounds.

Another common strategy is to extrapolate. As soon as Rayleigh announced the discovery of argon, William Ramsay predicted from Mendeleev’s periodic table of elements that there should be an entire column of previously unsuspected inert gases in addition to argon. He proceeded to isolate them. Rayleigh and Ramsay both won Nobel Prizes for their work.

Other scientists played mental games with current scientific dogmas, turning them on their heads, contradicting basic premises, or simply wondering “what if” some principle that everyone considered to be unquestionable were not. Analogies, metaphors, and even the re-creation of ancient historical experiments have all been touted as additional aids to discovery (Root-Bernstein, 1989) (see Analogies and Metaphors).

In conjunction with strategies of research, many scientists and inventors described using an unusual mental “toolkit” in making their discoveries. Strikingly, very few eminent scientists claim to use either mathematics or verbal languages to do their creative thinking. Einstein, in fact, stated explicitly (in what may amount to an over-statement) that, “No scientist thinks in equations” (Root-Bernstein and Root-Bernstein, 1999). He explained to his colleague Jacques Hadamard that in his case, he did his problem solving by using “certain signs and more or less clear images which can be ‘voluntarily’ reproduced and combined ... as well as muscular feelings ...” (Root-Bernstein and Root-Bernstein, 1999). Einstein also noted that the use of words and equations came only when the images and feelings had become well enough developed that they needed to be formally tested and communicated. Cyril Stanley Smith (1981), a metallurgist, similarly noted that “The stage of discovery was entirely sensual and mathematics was only necessary to be able to communicate with other people.” The use of visual images, kinesthetic feelings, and other non-verbal forms of thinking, as well translating insights into words and mathematics only in a secondary stage of developing ideas, is a very common (Root-Bernstein and Root-Bernstein, 1999) (see Imagery).

This non-verbal, non-mathematical nature of creative thought creates some interesting conundrums for understanding the nature of discovery. What is Stan Ulam talking about when he claims to “calculate, not by numbers and symbols, but by almost tactile feelings combined with reasoning” (Ulam, 1976, 17, 147)? To what was Richard Feynman referring when he talked about solving quantum physics problems using “acoustical images” (Root-Bernstein et al., 1995)? How do objective and verifiable results come from a process of thinking that has been described as entirely sensual, empathic, and subjective? Here, physicist-novelist C. P. Snow may hold the key:

If we could follow the process of scientific thought through many minds, as it actually happens and not as it is conventionally expressed after the event, we should see every conceivable variety of mental texture There are exactly as many ways of approaching the scientific world as there are individuals in science. It is only because the results are expressed in the same language, are subject to the same control, that science seems more uniform, than, say, original literature. In effect, in the end, it is more uniform.

Snow (1934, 258–260)

Unless the idiosyncratic and non-logical nature of thinking itself is recognized and the immense constraints that logical systems of communication place on how insights are expressed, there cannot be progress on this thorny problem. There is clearly a process of translation between individual and the scientific collective that is as essential to success as having the insight itself (Root-Bernstein and Root-Bernstein, 1999).

When Discoveries Are Made

Temporal patterns of discovery are perhaps the least-studied aspect of the discovery process, but some interesting phenomena have been observed. People tend to make discoveries within five to ten years of entering a field, and they tend to have only one major insight per field they enter. Thus, changing fields tends to restart the discovery clock, as it were – a phenomenon that has been called “the novice effect” (Root-Bernstein, 1989, p. 419).

Insights seem to occur more often when scientists are *not* directly working on a problem than when they are. Several studies have shown that only about a third of scientific problems are solved by a direct, brute force approach (Root-Bernstein et al., 1993). An equal number are solved when scientists give up on the original problem and begin working on a related problem. The remaining third of the problems get solved during leisure-time activities, which range from going on vacation to taking a shower to dreaming the answer in one’s sleep.

Discoveries tend to occur during times of economic growth and cultural mixing. The Scientific Revolution, for example, occurred during a period of prosperity associated with the Renaissance and this historical period is also characterized by many voyages of discovery that led to trade – both economic and intellectual – between cultures as diverse as the Europeans, Arabs, Chinese and Native Americans. Other major periods of innovation in the sciences, such as the Industrial Revolution and the post-Sputnik era, are also associated with such economic and cultural prosperity. One reason for this is that new technologies drive scientific advances. Harwit (1981) documented immediate and rapid innovation and discovery following the introduction of a novel technology into a scientific field, followed by an equally rapid drying up of novel results.

What Is Discovered

Much of the literature on discovery assumes that what is discovered is a solution to a problem. Thus, one popular book by Horace Judson about discovery is actually entitled *The Search for Solutions*. In fact, discovery is better characterized as a quest for questions (Root-Bernstein, 1989). The problem must be discovered before the search for its solution begins.

The greatest scientists often excelled at discovering new problems. Thus, Einstein once wrote:

The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and works real advance in science.

Einstein and Infeld (1938, 92).

Being able to perceive problems where no one else sees them is therefore one critical skill a discoverer can cultivate (see Problem Finding).

Outstanding problems are often as widely disseminated and discussed by scientists as are great experiments and theories. James Watson and Francis Crick, for example, tackled the well-defined problem of how genetic information is encoded and transmitted by living organisms. They neither discovered the problem nor the fact that DNA (deoxyribonucleic acid) carries genetic information. They did, however, make the very remarkable discovery of how the structure of DNA itself carries information and is adapted to replicating itself. This structure was quite unexpected (Watson, 1968).

All scientific discoveries are interwoven. Watson and Crick's discovery was only made possible by other types of discoveries. W. H. and W. L. Bragg had previously invented the technique of x-ray crystallography by which the structure of DNA was analyzed; Linus Pauling had developed sophisticated physicochemical modeling methods that Watson and Crick could apply to DNA; and so forth. In turn, Watson and Crick's discovery led to other discoveries. All of modern genetic engineering is based on the manipulation of DNA sequences and the enzymes that control DNA in cells – not one of which was foreseen even at the time of Watson and Crick's work (ca. 1950). Thus, it is correct to say that every discovery builds upon prior discoveries and, if it is valuable, makes new ones possible.

Where Discoveries Are Made

Where scientific discoveries are made is another under-studied aspect of the subject, and one that is full of surprises. One might expect discoveries to cluster in the major centers of science at any given historical period since these centers are where the most prominent scientists are to be found. For various reasons indicated above, including the inverse correlation between age and discovery and the generally conservative tendencies of most major institutions, the most interesting science is usually done in peripheral institutions.

Before proceeding further with this point, it is first important to distinguish between what Tomas Kuhn (1962) characterized as “normal” and “revolutionary” science. Kuhn defined normal science as having a well-articulated paradigm, or set of problems and problem-solving techniques, that can be described in textbooks and classrooms and implemented in laboratories. Normal science focuses on areas of science in which a major advance has opened up a well-defined set of problems that can be addressed with a fair assurance of success. Revolutionary science, on the other hand, is science that overtly challenges the assumptions of existing paradigms, undermining textbooks, making standard classes irrelevant or outmoded, and creating new methods of working and training. Since Kuhn, historians of science have begun to recognize a third category of science as well: new sciences. There was, for example, no science of physical chemistry until the late 19th century when scientists began to realize that the techniques of physics could be applied to chemistry. Physiology, immunology, molecular biology, biophysics, astrophysics, and ethology are other examples of new sciences that emerged during the last century, carving out new scientific territories without attacking existing sets of theories, practitioners, institutions, or textbooks.

Each type of science has its own geographical distribution. Normal science, does indeed cluster in established centers of science (Root-Bernstein, 1989). These centers have the resources and funding to attract recognized discoverers. These recognized centers are the places where the highest level of normal science is being carried out.

Breakthrough or revolutionary science tends towards the geographical peripheries of the scientific collective at any given time (Root-Bernstein, 1989; Root-Bernstein and Pawelec, 2016). There is a socio-economic price to be paid in challenging paradigms, so that, as one scientist put, one makes a choice between the “shackles of the palace or the freedom of the shack.” Many revolutionary scientists (Einstein is a well-known example) therefore spend their early careers unemployed or marginalized into peripheral institutions such as patent offices. One factor in this marginalization is that successful scientists often resist scientific innovations, sometimes even forcing innovators out. Hans Gaffron called this “resistance to knowledge” and it is a well-characterized phenomenon in the sciences.

New sciences also tend to emerge on the geographical peripheries of science (Root-Bernstein, 1989). Two sets of institutions tend to take up new scientific fields: major institutions that purposefully restructure existing departments to create a new one to embody the new science and its discoveries; and, more frequently, new institutions. For example, the new science of physical chemistry found its first homes prior to 1900 in the just-founded University of Amsterdam and at other virtually unknown colleges and universities in Tartu (Latvia), Toulouse and Bordeaux (France), Liverpool, Dundee and Aberdeen (UK), and Yale University in the United States (which was notable for its lack of scientific faculty at the time). Discoveries, in other words, tend to flourish where new opportunities for personal and institutional growth are available and there is lack of competition with established centers of practice.

Where one trains as an undergraduate has, notably, little or no effect on one's chances of getting into the National Academy of Sciences, the Royal Society or winning a Nobel prize, but where a scientist does their doctoral or post-doctoral training is critical (Root-Bernstein and Pawelec, 2016), perhaps because of the phenomenon mentioned above that most eminent scientists study with eminent mentors (see Mentors).

Why Discoveries Are Made

What motivates scientists to make discoveries? The basic drives seem to be control, curiosity, necessity, serendipity, and aesthetics. Often several of these drives are at work simultaneously.

Einstein commented that one of the primary reasons he became a scientist was to avoid the daily hassles of life. Many studies of the psychology of scientists and engineers suggest that they have a need for control. Creating theories or performing experiments provides that control. Control, in turn, yields power, since understanding nature allows human beings to manipulate nature's laws. Thus, discovery provides a means for individuals to obtain power over nature and their own circumstances.

Necessity can also be a motive for discovery. "Necessity is the mother of invention" is a well-known saying, no less true for its triteness. It is certain that many scientists, such as Louis Pasteur and Jonas Salk, have tackled questions of the cause of diseases precisely because of the threat these diseases posed to human beings.

At least half of all discoveries occur serendipitously, however (Root-Bernstein, 1989). A careful distinction must be made here between serendipity and chance or accident (Meyers, 2007). Chance and accident denote total lack of control of the process leading to discovery. No discovery has ever been made by chance or accident, despite many articles and books on these topics. When the laboratory notebooks detailing discoveries are examined, they inevitably reveal that all discoveries begin with some goal in mind. Those discoveries that are often said to have occurred by chance or accident turn out to have been made while looking for something else. Finding one thing while searching for something else is the definition of serendipity. Thus, Fleming, for example, discovered the antibiotic enzyme lysozyme in his mucus and tears when trying to isolate a virus that causes colds. Intention set up the experiments; serendipity yielded the surprising discovery.

Perhaps the most unexpected and yet common motivation for discovery is aesthetic (Wechsler, 1988; McAllister, 1996). A very large number of scientists are drawn to science in the first place by the beauty of the experimental preparations they examine in the microscope or the sublimity of the intellectual constructs that we call theories. Santiago Ramon y Cajal, who won a Nobel prize for his work in neuroanatomy often waxed eloquent over the magnificent scenes that the architecture of the brain afforded, while Max Planck said forthrightly that he was drawn to physics by the beauty of the laws of thermodynamics. In some cases, the desire to recreate literal physical beauty has even led to discoveries. For example, C. T. R. Wilson became so enamored of the coronas and glories that he observed when climbing in the Scottish hills that he decided to recreate them in his physics laboratory. His success inventing cloud chambers not only allowed him to make these beautiful optical phenomena at will, they also allowed subatomic particles to be observed for the first time, and earned Wilson a Nobel prize. Similarly, it appears that Fleming's habit of making "paintings" in petri dishes using a "palette" of colored microorganisms provided the basic techniques and observations that led to his discovery of penicillin.

Multiple or Simultaneous Discoveries

Many discoveries are made simultaneously by two or as many as a dozen other people or groups of people suggesting that common problems lead to common solutions. Discoveries that are made independently by more than one individual or groups of individuals are termed "multiple" or "simultaneous" discoveries (Kuhn, 1957). The probability of simultaneous discovery is hinted at by the fact that many other scientists saw what Fleming and Roentgen saw without thinking it. Sometimes, if a problem is well enough defined and the techniques for investigating it are available to enough people, several will converge on the same general answer at the same time. The simultaneous discovery phenomenon brings into contrast the extent to which discovery is dependent on unique forms of individual creativity and the degree to which there is a logic to discovery that is independent of individual psychology. The existence of simultaneous discoveries is also a prerequisite for understanding the controversies over priority that frequently occur in science.

The phenomenon of multiple discovery has been well documented in several cases. One is the invention of calculus by Newton and Leibniz at the end of the 17th century. Similarly, in the 1840s, Robert Julius von Mayer, James Prescott Joule, Ludwig A. Colding, William Robert Grove, and Hermann von Helmholtz (among others), all published versions of what would eventually become known as the first law of thermodynamics (energy is conserved). Numerous priority disputes broke out among the claimants. The co-publication of the theory of evolution by natural selection by Charles Darwin and Alfred Russell Wallace in 1858 is one of the few cases in which a simultaneous discovery did not result in friction between the co-discoverers, mainly because Darwin gave Wallace credit for his contribution and they co-wrote their first publication together.

Each example described above showcases the differences that always exist in the formulations of discoveries. Newton and Leibniz utilized very different, largely incommensurable notations. Darwin's formulation of natural selection was far more developed and encompassed a much wider range of phenomena than did Wallace's. Each of the formulations of the first law of thermodynamics has many more differences than it has similarities, and that it is only in retrospect, and largely due to the work of Helmholtz,

that one can recognize that all are partial statements of the same basic principle. Simultaneous discovery does not, therefore, necessarily, or even frequently, denote *identity* of discovery. Every investigator has a unique style of research that is manifested in how they pose problems, what tools they use to solve them, and how they present their findings.

What studies of simultaneous discovery tell us is that science-in-the-making is much more similar to art-in-the-making than might first appear. Style matters. Even when several scientists or groups of scientists make a common discovery, they imprint their unique personal and psychological factors onto that discovery so that no formulation is exactly like any other.

An Evolutionary Theory of Discovery

Evolutionary theory provides a unifying concept for understanding the process of discovery in all its manifestations. Kuhn (1962), for example, argued that an evolutionary model could be applied to science in his classic *Structure of Scientific Revolutions* and the argument has been elaborated since by Donald Campbell, David Hull, and the author (Root-Bernstein, 1989) among others.

In order to apply evolutionary theory to discovery, one must make analogies between species and ideas. Standard Darwinian evolution requires four key elements: 1) a source of diversity among species or ideas; 2) a way for individuals to inherit differences; 3) over-production of individuals so that not all can survive; and 4) a non-random means of selecting between differences. The sources of diversity are provided in part by nature, which generates the phenomena for scientists to observe, and in part by scientists, who invent techniques for exploring nature and explaining it. In practice, Chamberlin's method of multiple working hypotheses is always at work, often within the minds of individual scientists and certainly when the entire population of scientists is examined. At any given time in any area of active research, there is always a diversity of ideas and techniques being used or developed to explore the anomalous and unknown aspects of nature. Because individual scientists are trained at different institutions (recall the central-peripheral distinction made above) they integrate different sets of knowledge and techniques into their thinking and work resulting in a diversity of possible ways to know and explain nature.

The inheritance of variations occurs by means of learning and teaching in cultural evolution. Thus, ideas and information (sometimes called "memes") take the place of genes. Evolution, in consequence, is more Lamarckian than Darwinian. Lamarck maintained that species evolve by willing themselves to change and argued that alterations during their lifetimes could be transmitted genetically. Lamarck's mechanism has been completely dismissed as a means of biological evolution but may still apply to cultural evolution since people can, in fact, change their minds and transmit their altered ideas to the next generation of scientists. Unlike genetic evolution, learning is acquired and filtered by experience, expectation, and belief systems.

The third factor necessary for an evolutionary system is over-production of the diversity of inherited traits. If every scientific observation and every scientific hypothesis were considered to be equally valuable and valid, then there could be no progress. Scientists compete for grants, resources, students, publications, positions, prestige. Some are more fecund than others, passing on their ideas and techniques more efficiently than others. Only some can "survive" to become contributors to the scientific enterprise.

Finally, evolution requires a non-random means of selecting between competing ideas, methods, observations and experimental results. Here a combination of natural and artificial processes come into play. The touchstone of all science is nature itself. The scientist presumably compares observations and theories by means of tests with nature. Often, however, several explanations may account for existing observations equally well. In this case, other criteria, such as the compatibility of the various explanations with other scientific principles, the range of phenomena explained, its simplicity and usefulness, and aesthetic criteria come into play. Unfortunately, from a purist perspective, scientific ideas and results are also subject to social norms and expectations, transient fads, and political and economic factors. Such constraints may be as important as scientific considerations in determining which discoveries thrive or even survive at any given point in history or in any given society. The point is that selection does occur and competition amongst scientists, their observations, and theories is very rigorous if not always constrained to scientific considerations.

In sum, the discovery process fits a Lamarckian form of evolution. Evolutionary theory also accurately describes other elements of the discovery process. One is the literal growth of each new development in science from previous discoveries. Every discovery builds on previous discoveries. If necessity is the mother of invention, then existing discoveries are the fathers. One of the explicit "rules" by which most scientists abide is that new theories and discoveries must incorporate the existing body of scientific knowledge and understanding. Continuity with the knowledge and understanding accumulated in the past is a requirement for ongoing progress. There can be no clean breaks, even in revolutionary science, with what has already been established – only in how everything that is known can be more coherently and consistently explained.

An evolutionary model also describes accurately the increasingly specialized nature of discoveries in science. If one looks at science since the 17th century, it has developed in almost perfect imitation of a taxonomic tree. As of 1670, there was one journal of science, and all of science was generally categorized under the heading "natural history". Over the next century, the number of practitioners grew exponentially, as Derek de Solla Price so well documented in his classic *Little Science, Big Science*, creating a need for new and more specialized journals. The specific sciences of astronomy, physics, chemistry, and biology were all recognized by the end of the 18th century. During the nineteenth, exponential growth in the number of chairs of science, journals, practitioners, and papers all continued resulting in further specialization. Chemistry split into physical, organic, inorganic and biochemistry, for example. At present, the discipline recognizes over a hundred specialties in which doctorates can be obtained and papers published. Every scientific field has branched into similarly diverse specialties. From the trunk of natural philosophy have emerged the general branches of the basic sciences, followed inexorably by the twigs that have produced the

current crop of thousands of leaves that represent the crown of science as it exists today. Scientists diverge and specialize just as do species.

Many aspects of the evolutionary theory of discovery remain unresolved, however. For example, standard evolutionary theory places primary emphasis on the random generation of extremely large numbers of variants from which the best adapted can be selected. The implications of this approach for discovering are that an investigator should try as many random ideas or processes as possible in order to optimize his or her chances of making a discovery. Physicist [Henri Poincaré \(1946\)](#) placed the greatest emphasis on the selection process. Anyone can, he argues, find two ideas, theorems, facts, or techniques that have not been synthesized before and attempt to synthesize them. Most of the results will be useless or trivial. Poincaré therefore argues that what is most important is having an aesthetic sensibility that allows the discoverer to sort the wheat from the chaff: “To invent is to choose.” ([Poincaré, 1946](#)).

Another equally important difference between standard models of biological evolution and models characterizing cultures such as science concerns integration. Standard Darwinian evolution is portrayed as a tree that constantly branches. The most adapted new variants are the ones that survive through time. But much of scientific progress is characterized by the integration of previously separate lines of investigation, searching for “unified field theories” or their equivalents. Thus, the trees that represent scientific discoveries not only branch, but they also meld back together, forming a dense network of interactions. Symbiosis or synthesis yielding new sciences and more integrated theories is as important as speciation or specialization.

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Disruptive Innovation

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Innovation Versus Creativity

It is beguiling how the terms “innovation” and “creativity” are being used by different social actors including managers, educators, engineers, policymakers, and even leaders of countries. In a recent speech, Emmanuel Macron, the President of the French Republic, asserted that “the goal of making us stronger, restoring our ability to innovate, to produce, to reduce unemployment, particularly among the youngest people.” Theresa May, the former Prime Minister of the United Kingdom, declared, “I want us to be a secure, prosperous, tolerant country—a magnet for international talent and a home to the pioneers and innovators who will shape the world ahead.” And Barack Obama, the former President of the United States, mentioned, “Our single greatest asset is the innovation and the ingenuity and creativity of the American people ... It is essential to our prosperity and it will only become more so in this century.” Indeed, there are more examples of leaders who have acknowledged the significance of creativity and innovation as valuable human resources. However, where do these concepts overlap and where are they separate?

One of the greatest insights of Jean Piaget is expressed by his metaphor “To Understand is to Invent.” Misunderstanding the similarities and differences between innovation and creativity can cause confusion. One commonality between innovation and creativity is that both refer to ideas and products that are both novel and useful. In fact, few researchers explicitly distinguished between these two terms (e.g., Amabile and Pratt, 2017 ; Runco, 2014). Amabile and Pratt (2017) stated, “creativity, which we define as the production of novel and useful ideas by an individual or small group of individuals working together, is often conceived as the ‘fuzzy front end’ of innovation, which we define as the successful implementation of creative ideas within an organization” (p. 158). This definition suggests that creativity is a prerequisite for innovation; without creativity there is no innovation. Second, although both require some degree of novelty and utility, they differ in the novelty-utility ratio (Runco, 2014). Innovation requires new ideas with the main emphasis on utility, whereas creativity requires more originality or novelty. As Runco (2014) put it,

Innovation often requires that the result is maximally effective (it should sell or be publicly useful). Originality is secondary, though necessary. In creative performances that are not innovative, such as arts, originality may be much more important, whereas effectiveness is secondary. (p. 398)

School children might figure out a creative solution for a particular problem; however, they find it difficult to implement their ideas because of a lack of resources and/or knowledge. This takes us to usage. Creativity is used in educational contexts, while innovation is extensively used in organizations. This makes sense because companies and organizations focus on the effectiveness of innovative products and processes.

The final difference concerns motivation source. Creative individuals are driven by their intrinsic motivation to solve a problem, generate ideas, or create artistic expressions; whereas, innovation is mostly driven by extrinsic motivation (that is, making a profit). In business, for example, managers and investors care more about the implementation of creative ideas, that is, how much money a product will bring to the company. Recently more interest has been shown in innovation in non-profits where utilizing funds efficiently and effectively is crucial to the success of organizations. In summary, although innovation and creativity might overlap with each other, these two terms are not synonymous. The focus of this entry is on innovation, and more specifically, disruptive innovation.

What Is Disruptive Innovation?

Disruptive innovation has been scrutinized by researchers from various academic disciplines including economics, education, and medicine. Perhaps the term itself is catchy, or maybe the theory of disruptive innovation is very appealing and convincing. Although

the theory of disruptive innovation was introduced first in 1995 by Clayton Christensen and colleagues, the idea of market “disruption” was studied by the Austrian politician and economist, Joseph Schumpeter in the 1940s. In his book, *Capitalism, Socialism and Democracy*, Schumpeter inaugurated the idea of creative destruction, which he defined as “a process that revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one” (Schumpeter, 1942, p. 83). The question is what are the factors contributing to selective market destruction? Through observing cases in which successful firms—with capital, capable employees, and expert leadership—were “disrupted” by entrants who had less resources, Christensen and his colleagues introduced the theory of disruptive innovation, which has since been extensively researched.

Christensen and his team elaborated on the theory of disruptive innovation through different articles and books such as *The Innovator's Dilemma*, *The Innovator's Solution*, and *Disrupting Class*. Christensen et al. (2017), defined disruptive innovation as:

A process whereby a smaller company with fewer resources is able to successfully challenge established incumbent business. Specifically, as incumbents focus on improving their products and services for their most demanding (and usually most profitable) customers, they exceed the needs of some segments and ignore the needs of others. Entrants that prove disruptive begin by successfully targeting those overlooked segments, gaining a foothold by delivering more-suitable functionality—frequently at a lower price. Incumbents, chasing higher profitability in more-demanding segments, tend not to respond vigorously. When mainstream customers start adopting the entrants' offerings in volume, disruption has occurred (p. 31).

According to this definition, disruptive innovation occurs as a result of an established incumbent's focus on customer needs and on research and development. As a consequence, established firms overshoot the market by presenting products that exceed the needs of customers. This definition also suggests that although the incumbents have the adequate resources to respond to the disruptive innovation; they ignore that disruption. By doing so, established firms open the door for those ignored entrants to dominate the market.

New entrants start by targeting customers who cannot afford to buy a product or a service because it is too expensive and/or exceeds their needs. Entrants, therefore, offer convenient, simpler, and cheaper products or services that satisfy those needs. With time, entrants develop their products to attract mainstream customers who are willing to pay less for a product or service that meets their needs (see Fig. 1; Christensen et al., 2015, p. 49).

In order to support their theory, Christensen and colleagues provided more than 70 examples of disruptive innovation featuring large corporations such as Amazon.com, eBay, and Southwest Airlines as well as examples of breakthrough technology such as disk drives and hydraulic excavators. Table 1 lists examples of disruptive innovations mentioned in Christensen and Raynor's (2003) book *The Innovator's Solution: Creating and Sustaining Successful Growth*. The following section offers examples of disruptive innovations that fit under three main categories: (a) technological innovation, (b) catalytic innovation, and (c) business-model innovation.

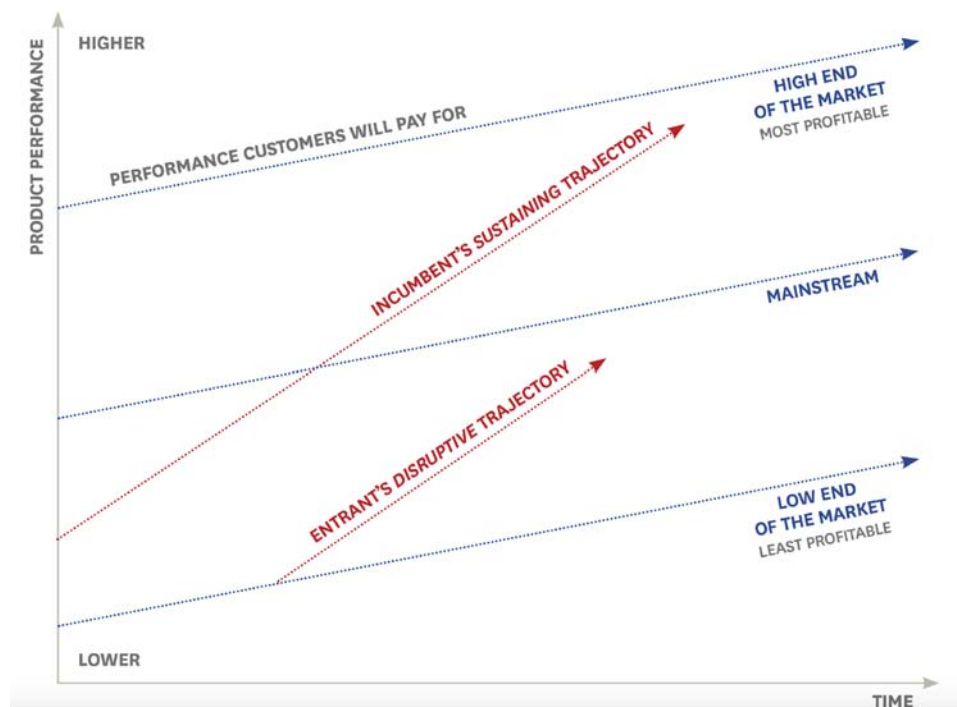


Figure 1 Product performance trajectories (Christensen et al., 2015, p. 49).

Table 1 List of disruptive strategies and companies (Christensen and Raynor, 2003, Table 2-2).

802.11	Amazon.com	Barnes & Noble
Beef processing	Bell telephone	Black & Decker
Blended plastics	Bloomberg L. P.	Boxed beef
Canon photocopiers	Catalog retailing	Charles Schwab
Circuit city, best buy	Cisco	Community colleges
Control school of law	Credit scoring	Dell computer
Department stores	Digital animation	Digital printing
Discount department stores	eBay	ECNs
E-mail	Embraer and Canadair regional jets	Endoscopic surgery
Fidelity management	Flat-panel displays	Ford
Galanz	GE capital	Google
Honda motorcycles	Ink-jet printers	Intel microprocessor
Intuit's QuickBooks accounting software	Intuit's TurboTax	Japanese steel makers
JetBlue	Kodak	Kodak Funsaver
Hyundai and Kia	Linux	MBNA
McDonald's	MCI, sprint	Merrill Lynch
Microsoft	Minicomputers	Online stock-brokers
Online travel agencies	Oracle	Palm Pilot, RIM BlackBerry
Personal computers	Plastics	Portable diabetes blood glucose meters
Salesforce.com	Seiko watches	Sonosite
Sony	Southwest Airlines	SQL databases software
Staples	Steel minimills	Sun Microsystems
Toyota	Toys "R" Us	Ultrasound
University of Phoenix	Unmanned aircraft	Vanguard
Veritas and Network Appliances	Wireless telephony	Xerox

Examples of Disruptive Innovation

This section offers three examples of disruptive innovations: (a) the advent of personal computers (PC), a technological innovation; (b) the appearance of online courses, a catalytic innovation; and (c) Southwest Airlines, a business-model innovation. The first example, the advent of personal computers, is an example of a catalytic innovation. The whole notion of disruptive innovation grew from studying technological products that replaced other products such as hard drives (1954 computer advance), hydraulic excavators, electric cars, ultrasound, and digital printing (Christensen, 1997). In the 1950s, IBM and other companies introduced the mainframe computer, which was at that time the most advanced computing machine. It was only available to customers who could afford paying hundreds of thousands of dollars. Consequently, IBM and other major players kept improving mainframe computers without paying attention to minicomputers, which were of interest to only a few customers.

Developers of minicomputers such as Digital Equipment Corporation started targeting consumers who were looking for a relatively inexpensive computer. Interestingly, Digital Equipment Corporation and other producers of minicomputers were later displaced by aggressive newcomers to the market such as IBM, Apple, and Dell which introduced affordable user-friendly computers, which targeted the mainstream customers (i.e., personal computers). Today, the cotemporary market is very broad from wrist size to wall size computers. Supply and demand varies throughout the market spectrum. Will laptops be replaced by tablets that are smaller, easier to carry, and cheaper? Apple offers smart keyboard and Apple Pencil for iPads, which make this tablets competitive, if not superior to many laptops' products.

The second example of disruptive innovation occurred in education, especially higher education, where online courses radically challenged face-to-face instruction. Online course delivery was a new technology that had broad social impact. Online universities appeared and many major universities had to adjust to the demands for convenience. Delivering course content over distance created a new market area and challenged ideological norms. It gave people in rural communities' equal opportunity to gain university degrees. Christensen et al. (2006) called it "catalytic innovation." According to Christensen et al. (2006, p. 1), "Catalytic innovations are a subset of disruptive innovation, distinguished by their primary focus on social change, often on a national scale." Online courses changed K-12 as well as higher education's traditional method of teaching (i.e., face-to-face).

Online courses have lowered the costs and the time associated with gaining an academic degree. It offers flexible scheduling for students and professors. There are various modes for the delivery of course instruction: Online classes can be hybrid (face-to-face and online), synchronized, and asynchronized classes. In synchronized classes, students and instructors interact with each other's during a scheduled time period, while with asynchronized classes interaction is more flexible. Although online courses can be considered an innovative method of teaching, they might not be categorized as a disruptive innovation. Since the 1990s, universities have offered online courses, but this technology did not allow online universities to usurp incumbents (i.e., top universities). Highly rated universities such as Stanford, Harvard, MIT, and Oxford were not radically affected by online courses, though they incorporated their use. These universities remained at the top of the rankings for higher education institutes. Christensen et al. (2018) admitted that the speed of disruption differs across industries and within a particular industry. Another example of "immune to

disruption" is the hotel industry. Although some new entrants such as Airbnb offer a cheaper and more convenient options for travel, major players such as Four Seasons, Marriott, and Hyatt hotels are still dominating the hotel market.

Finally, the third type of disruptive innovation is the business model. Although incumbents and entrants might possess the same technological capabilities, entrants disrupt established firms by introducing a new business model that targets low-end customers who are often neglected by incumbents. Perhaps the most extensively studied case of a business model innovation is Southwest Airlines. In 1971, when major players in the airline industry were competing against each other by developing their fleets (that is, better *business* and *first-class* services, new routes, and different plane size), Southwest Airlines started their business in Texas serving three cities. Southwest Airlines introduced a new business model, a low cost carrier, which focused on minimizing operation cost by: "(a) flying one model of plane rather than several, (b) a point-to-point route structure rather than hub-and-spoke, (c) one class of services rather than many, and (d) no meals, no assigned seating" (Raynor, 2011a, p. 31). What happened in this case of disruptive innovation is that Southwest Airlines offered a new business model, not a technology. This new business model attracted a segment of consumers who were looking for cheaper fares and did not mind landing in secondary airports. Today, Southwest Airlines is one of the largest Airline companies in the United States and the world.

The next section will review some of the criticisms that have been raised to challenge the theory of disruptive innovation. These challengers examined the predictive validity of the theory through a reexamination of the cases that Christensen and his colleagues reported.

Criticisms of the Theory of Disruptive Innovation

The theory of disruptive innovation received criticisms from experts in the fields of innovation and management. These criticisms can be classified into two categories: (a) experts who stressed distinguishing the different kinds of disruptive innovations, and (b) experts who challenged the theory's predictive validity.

Although the original theory of disruptive innovation mainly focused on disruptive technologies (Christensen, 1997), the theory evolved to include other kinds of innovations such as social (catalytic) innovation and business-model innovation. The problem, as indicated by a number of experts, was that the disruptive innovation theorists equated all three kinds of disruption. For example, Markides (2006) stressed the importance of distinguishing between (a) business model innovation, (b) technological innovation, and (c) radical product innovation.

Unlike disruptive technology, one of the elements that characterizes the business model innovation is that the entrants compete against incumbents in an *existing market*. Southwest Airlines, Amazon.com, Swatch, and online courses are examples of business model innovation. Amazon.com did not discover bookselling, rather, it introduced a new business model that challenged the traditional publishing houses distribution system. Amazon.com was one of the first to take advantage of the online shopping by featuring books at a lower price than book stores. The same economic incentive for the consumer inspired walk-in-clinics such as MinuteClinic and MedExpress, which offered less expensive healthcare services for uninsured people and for insured patients who did not have serious health problems. None of these examples of disruptive innovations invented a new market; they competed with incumbents within the same industries. The second feature that characterized the business model innovation is that it often uses a low cost value-chain, which make it difficult for established incumbents to respond.

The second kind of disruptive innovation is *radical* innovation. This kind of disruptive innovation occurs when a product of service creates a *new market*. According to Markides, "Radical innovations are disruptive to consumers because they introduce products and value propositions that disturb prevailing customer habits and behaviors in a major way" (p. 22). Airplanes, TVs, iPods, PCs, radios, and mobile phones are all examples of radical innovation. Most of the examples provided by Christensen (1997) represented radical technological disruptions where new entrants replaced incumbents; hydraulic excavators replaced steam shovel excavators, steam-powered ships replaced wind-powered ships, and USB flash drives replaced floppy disks.

The most serious wave of criticisms of the theory of disruptive innovation concerns the predictive power of the theory. King and Baatartogtokh (2015) comprehensively examined 77 cases reported by (Christensen, 1997; Christensen and Raynor, 2003). King and Baatartogtokh (2015) surveyed and interviewed at least one expert on each of the 77 cases.

In order to identify a product or service as a disruptive innovation, it should meet four criteria that describe the market place: (a) existing firms are involved in sustaining innovation in order to satisfy their customers' needs, and increase profits, (b) firms sustaining innovation overshoot the market with products or services that exceed customers' needs, (c) although existing firms have the capability to respond to the entrants, they ignore the disruption, and as a result, (d) they lose capital or market share (see Fig. 2; King and Baatartogtokh, 2015, p. 83).

Surprisingly, King and Baatartogtokh (2015) reported that not all cases cited by Christensen involved a firm in the process of "sustaining innovation" when a new entrant appeared. For example, slaughterhouses were disrupted by boxed beef not because they were focused on sustaining innovation, but because it would take time to adopt a new business-model. The same can be said about other cases of disruptive innovations where the process of sustaining innovation was not the real factor for the cause of the disruption.

Second, in the majority of cases, experts concluded that the emergence of a disruptive innovation was not the result of incumbents overshooting customers' needs. For example, internet search engines did not disrupt printed dictionaries market because publishers created dictionaries that exceeded customers' needs. The internet and search engines materialized and created new

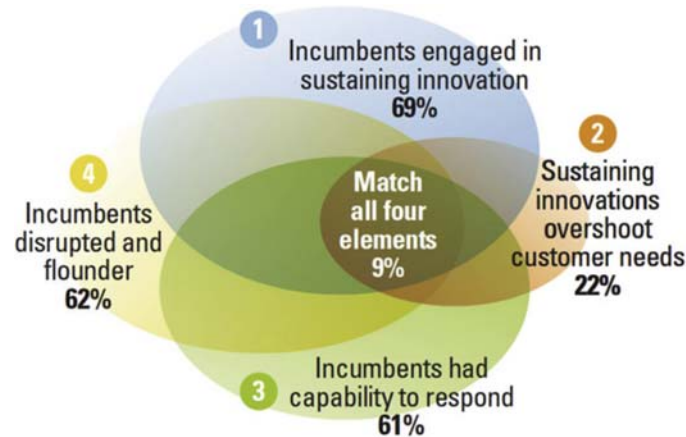


Figure 2 Experts opinions on cases of disruptive innovations (King and Baartartogtokh, 2015, p. 83).

markets. The same can be said for the postal service, which has been disrupted by email; however, the postal services did not overshoot their market with a postal service that exceeded consumers' needs.

Third, Christensen and Raynor (2003) indicated that firms had the capability to respond to the rival's disruption, but they ignored them. In some examples of disruptive innovations, incumbents were incapable of responding to entrants because they were restricted by some laws and regulations (e.g., US airlines were not allowed to compete on price until 1979). Moreover, some firms were incapable of responding to the new disruption because they did not have the capability to compete in new businesses. For instance, incumbents in wood products were incapable of responding to plastic products because such a respond would require them to have the skills and tools to do so.

Finally, in many cases, entrants did not replace firms' products or services. Online banking services for example, did not replace the traditional banking services (Markides, 2006). Similarly, Southwest Airlines, online travel agencies, and Amazon.com did not replace incumbent airlines, traditional travel agencies, and bookstores respectively.

All in all, criticism might help enhancing the theory of disruptive innovation. Although the theory has a history of 20 years, and although many articles and books extensively discussed the theory, more rigorous research is needed to prove the theory's predictive power.

Conclusion

The term "disruptive innovation" has been widely used by experts and practitioners in different fields of study. In some cases, the term has been used incorrectly with regards to the theory of disruptive innovation. Christensen (2014) himself showed a concern of misuse of the term disruptive innovation: "The choice of the word disruption was a mistake I made 20 years ago and I never thought about the word disruption in the English language has so many connotations, that people would then flexibly use an idea, twist it, and use it to justify whatever they want to do in the first place." This assertion seems to be valid. Many people, experts or practitioners, use the term "disruptive innovation" without reading a single book about the theory. But this is not the only reason for misunderstanding of the theory. Another factor contributed to a misunderstanding is the lack of empirical studies on the theory.

That is not to say that there is not empirical investigations that tested the theory's predictability. For example, Raynor (2011b) conducted an experimental study to test the predictive power of the theory. Raynor (2011a) used Intel's New Business data for 48 businesses: only 5 businesses succeeded. In the first phase of the experiment, Raynor (2011b) randomly selected six cases and asked participants to predict the success rate. Participants correctly predicted only 10% of the cases. In the second phase of the experiment, participants received a training on the theory of disruptive innovation and then were asked to predict another set of cases. The results showed that the prediction rate increased from 10% to 15%. However, an increment of 5% is not overwhelming. The theory of disruptive innovation still has a long way to go to be empirically proven, however it still offers a good framework for researchers and industries by providing general guidelines for successful companies to anticipate and respond to possible disruptions. Granted, there will be more cases of disruptions in the future given the accelerated rate of knowledge and technology.

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Divergent Thinking[☆]

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Glossary

Criterion problem There is no widely accepted criterion of creativity. If there were such a criterion, there might be no need for any other test or indicator of creativity. The criterion problem recognizes circularity: to find a good criterion of creativity, it must be tested against a good criterion of creativity.

Experiential bias Some divergent thinking tasks may allow respondents to draw from memory and experience rather than testing the cognitive capacity to generate ideas

Ideational flexibility The number of themes or categories within an examinee's or respondent's ideation

Ideational fluency The total number of ideas given by any one individual on any one divergent thinking exercise

Ideational originality The unusualness or uniqueness of an examinee's or respondent's ideas

Ideational pools These are constructed for each examinee or respondent and contain all of that individual's ideas. Judges can evaluate the pools rather than individual ideas. This means that judges have much more information and it less time-consuming and thus a cost-efficient method.

Structure of intellect J. P. Guilford's model, with 180 different kinds of intellectual processes and skills.

Background

J. P. Guilford is typically credited with first distinguishing between divergent thinking and convergent thinking. (The latter is involved whenever an individual thinks only about correct or conventional ideas and solutions. Convergent thinking is what is tested by most academic examinations and IQ tests.) Guilford also argued cogently for creativity being a natural resource and is credited with initiating the empirical research on the topic in the 1950s and 1960s. Certainly he was the first to be explicit about the value of divergent thinking, and he did most of the early research on the topic as he developed his structure-of-intellect (SOI) model. (This model contained 180 cells, many of which represented "divergent production," which was Guilford's own term for divergent thinking.) Several others before Guilford did recognize the importance of divergent thinking, even if they did not call it that. Alfred Binet, for example, had several open-ended questions that required his examinees to think divergently on his early tests of mental abilities. These tests were later adopted by Louis Terman of Stanford University and refined as the first IQ tests (i.e., the Stanford-Binet). Binet was working on his tests in the late 1800s, but again, his focus was mental ability, not creative potential.

Guilford's work represents the most comprehensive model of divergent thinking. His SOI did not fare well as a whole, but tests of divergent production have proven to be quite useful as estimates of the potential for creative thinking.

[☆] *Change History:* October 2019, Mark Runco updated the text throughout the article.

This article is an update of M.A. Runco, Divergent Thinking, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 400–403.

Several other theories are largely supportive of divergent thinking as an estimate of the potential for creative thought. In 1962, Sarnoff Mednick published his 'Associative Basis of the Creative Process,' and although he developed his own test, the Remote Associates Test (RAT), the associative theory presented by Mednick also supported and encouraged the use of divergent thinking tests. Importantly, the RAT may be verbally biased. Individuals who do well on tests of verbal ability often do well on the RAT, and persons who do poorly on tests of verbal ability tend to do poorly on the RAT.

In associative terms people respond to problems by generating ideas. Often one idea leads to another idea, which leads to another. Mednick discussed various ways that one idea could be associated with another idea, including acoustic similarity or functionality. Very importantly, he predicted that ideas found later in an associative chain are more likely to be original than those found early in that chain. This prediction has been supported a number of times, often with divergent thinking tests.

Some of the newest work on divergent thinking extends the associative idea to cognitive hyperspace. This is the label for a category of thought which is found by following one line of thought, and then turning 90° to a connected but perpendicular line of thought—and then turning again, and again, and again. In the natural environment there are only three dimensions (height, width, and depth) but in mathematics and various theoretical fields, hyperspace is possible. According to [Acar and Runco \(2015\)](#), some of the most creative ideas are found by exploring cognitive hyperspace instead of following one associative pathway.

The prediction from Mednick about 'remote associates' is very important in a practical sense because it suggests that individuals taking a divergent thinking test or working on a problem that will benefit from creative insight should make certain that they invest some time into the task. Otherwise remote and original ideas might not be found. It takes time to move from idea to idea and to eventually discover a remote associate. Educators and managers who would like to see their charges be creative should also be sure that the time provided is generous, and perhaps unrestricted.

A verbal bias was mentioned above, in the discussion of the RAT. Divergent thinking tests do not seem to suffer from a verbal bias but an experiential bias may come into play. After all, if an examinee is asked to "list things that move on wheels," and he or she grew up in an extremely isolated area where vehicles are uncommon or are all pretty much the same, that examinee will not have much information in long term memory. Another person, growing up in an area where most households own several vehicles, may have a huge advantage, at least in terms of available information. Yet that person may rely on long term memory and only think of things with which he or she had direct experience. When a test assesses experience and memory more than cognitive skill it is said to be *experientially biased*. At least one empirical study uncovered a bit of an experience bias in certain tests of divergent thinking, but the degree of bias apparently varies from test to test and from task to task. This takes us to a review of the different kinds of divergent thinking tests.

Tests and Example Questions

Guilford developed a large number of tests. As noted above, he was interested in the structure of the intellect and in distinguishing among 180 different kinds of thinking. (Most criticisms of Guilford's work are directed at his statistical methods, used to separate the different kinds of thinking. He often used a kind of factor analyses that required that subjective judgments be made by the psychometrician.) The three tests used most frequently by Guilford were probably Plot Titles, Consequences, and Alternative Uses. Plot Titles required the examinee to think of a title for a story that was presented. A modification of Titles, which is part of the rCAB battery, does not present a story but instead refers to famous movies or books, such as Titanic, or Romeo and Juliet, or the Hobbit, and then asks examinees to generate alternative titles. Guilford's Consequences test asks examinees to list the implications of some hypothetical situation (e.g., the world is suddenly covered with water). Alternative uses asks the examinee to generate uses of some common object (e.g., a coat hanger or brick). Versions of the Uses test are probably used more often than any other test of divergent thinking, though psychometric analyses indicate that it may be one of the least trustworthy in terms of reliability and internal consistency.

E. Paul Torrance developed the *Minnesota Tests of Creative Thinking* in the late 1950s (published in 1966). They contained a wide variety of tasks. They were revised in 1974 as the *Torrance Tests of Creative Thinking*. Examples include Just Suppose, Product Improvement, Ask and Guess, Unusual Uses, Thinking Creatively with Words, and Thinking Creatively with Pictures. Torrance's work was extended in various directions. This was a big step because it is informative to understand the creative potentials of very young children and because paper and pencil tests cannot be used with child at a young age. C. Woodruff Starkweather, for example, published materials describing the assessment of original ideation in preschool children. The divergent thinking of young children can be assessed, though not with paper-and-pencil tests. Instead three-dimensional forms are given to them and they are asked to talk about all the things the tangible object could be. A more recent method, piloted in 2018, shows children a 3D object on a computer screen and allows them to interact with it using a touch screen, so they can rotate the object, or zoom in or out, just to name three touch screen options. The children talk about what the object could be while they play with the touch screen, and the device records this narrative. It is transcribed with computer software and ideational fluency, originality, and flexibility scores are then extracted.

Various other batteries are available, in addition to those of Guilford and Torrance, including the rCAB, just mentioned, Roberta Milgram's *Tel Aviv Creativity Test*, the Williams Creativity Assessment Package, and a battery used in several seminal investigations by Michael Wallach. The last of these contains three verbal tests (Uses, Similarities, and Instances) and two Visual (or Figural) tests (Line Meanings and Pattern Meanings) and has proven to be enormously informative in several significant research projects, including those reported in *The Talented Student* and *Modes of Thinking in Young Children*. Wallach's tests and research set the stage for a large number of studies of divergent and creative thinking.

Divergent Thinking Indexes

Divergent thinking tests are scored in different ways, although most of the time a Fluency score and an Originality score are each calculated. These are the most common indices of divergent thinking. Fluency represents the number of ideas given. Originality is scored in a variety of ways. An objective score for originality might be calculated after determining the statistical infrequency of each idea. Highly infrequent ideas (e.g., those given by 5% of a particular sample) can be labeled original, each contributing to the Originality score. Unique ideas (i.e., given by only one person in any particular sample) are sometimes viewed as original. Uniqueness is more difficult in a larger sample, in which case unusualness scores should be used. Subjective scores have also been used, with judges rating the originality of ideas but, as is true of all scientific work, it is more objective to avoid raters and judges. There are good objective indices so there is no reason to use judges or raters with tests of divergent thinking. This is especially true because computerized systems have been developed for scoring divergent thinking tests (Acar and Runco, 2015; Beketayev & Runco, 2016; Dumas and Runco, 2018; Hass, 2017).

The next most common score is probably Flexibility. This is a very important score because high flexibility (a) precludes rigidity in problem solving and (b) guards against an artificially inflated originality score. Without a Flexibility score, one examinee could give a large number of unique ideas, all within the same category, and each would earn an Originality point even though they are not original compared to one another. If the examinee relies on one conceptual category but Flexibility is scored, the Originality score will be high but the low Flexibility score will indicate that Originality is inflated and not useful.

In 2004 Allan Snyder and associates developed and tested a new index of divergent thinking which they called the creativity quotient (CQ). It assumes that ideas produced may not be equally indicative of creative potential. Those in disparate semantic categories are therefore weighted heavily and contribute more than semantically similar ideas to the CQ. In some ways the CQ takes both fluency and flexibility into account at the same time.

The various indices of divergent thinking are frequently highly intercorrelated. This has led some researchers and examiners to conclude that only one score is necessary. Unfortunately, when one score is used, Fluency is usually the one chosen. It would make more sense to use Originality given that, in theories of creativity, originality is more important than fluency. Actually, it is probably best to use several scores because sophisticated statistical techniques (e.g., partialing unique variance and examination of interactions in canonical prediction equations) suggest that the different indices may each contribute useful information. In addition the newer computer scoring methods provide indices and scores that are not at all highly intercorrelated (Dumas and Runco, 2018).

The scoring of the Torrance divergent thinking tasks involves Fluency, Originality, and Flexibility, defined in a way that is comparable to the definitions given above. Torrance also recommended an Elaboration index for some of the tasks. This is based on the examinee's ideation within a category or theme. The examinee elaborates on one theme by following and extending it. A streamlined scoring system was developed for the Torrance tests in 1980. It uses a composite of the various indexes.

Not long ago Runco developed a scoring system that uses *ideational pools*. These pools are constructed for each examinee or respondent and contain all of that individual's ideas. Thus ideational pools contain a person's entire ideational output. The pools rather than individual ideas are then evaluated. There are at least two advantages of this system. First is the amount of information available to judges who may be involved in the scoring. Second is that only pools are evaluated, not each and every idea, so much less work is involved. Judges have more information because they see everything any one examinee or respondent did, not just a small portion of it (i.e., one idea). The judges can give one rating or judgment to each pool, rather than to each idea, so they need to invest much less time in the evaluations. This may preclude fatigue and allow them to concentrate better, and it requires less of their time. Still, recall here what was said above about the problems with judges (i.e., subjectivity and differences among groups of judges) and the possibility of using more objective measures that do not rely on judges.

Task Differences and Additional Tests

The various divergent thinking tests differ in significant ways. The Similarities test (e.g., how is a car like a jet?), for example, is relatively constrained and not quite as open-ended as some of the other tasks. The Instances test (e.g., "make a list of strong things") seems to be more open. The degree of openness is important because more openness is likely to allow more divergence and more originality, and possibly more flexibility as well. Also important is that openness is relevant to the order of test administration. If examinees have difficulty with divergent thinking, for example, which they might if they are in the midst of the 'fourth grade slump' or simply have had little or no practice at generating a large number of ideas, it might be best to start with Similarities. Because of its structure and relative constraint, it is likely to be the most familiar to examinees who are familiar with closed-ended academic tests but unfamiliar with open-ended tests. After working on Similarities, they might be presented with a slightly less constrained task, such as Uses, and then eventually a completely unconstrained task, such as Instances. This is essentially a "fading" method, from operant psychology, applied to the testing of divergent thinking.

Significantly, divergent thinking tasks can be used in a practical setting, as exercises. Here they are used to provide practice with and feedback on divergent and creative thinking, and very likely there is no actual test or assessment, just exercises. When divergent thinking tasks are used in this fashion, for practice, it is probably desirable that the skills or strategies students learn from divergent thinking generalize to the natural environment. For this reason realistic divergent thinking tasks might be given. These ask examinees to solve problems that might be encountered in the natural environment. These problems that are still open-ended and allow fluency, originality, and flexibility. Shawn Okuda developed a number of realistic tasks that are now part of the rCAB battery. Other

realistic tests are based on SWOT theory and allows research on the ideation of entrepreneurs. SWOT theory points to the strengths, weaknesses, opportunities, and threats to and of a business.

Examples of realistic tests are given below to bring home several of the points made above. The examples provided below are from tests designed for students.

Example Problem 1

Your favorite TV show was on last night. You had so much fun watching it that you forgot to do your homework. You are about to go to school this morning when you realize that your homework is due in your first class. Uh-oh ... what are you going to do?

For this problem, you could answer, "Tell the professor that you forgot to do your homework; try to do your homework in the car or bus on the way to school; ask your roommate, boyfriend, girlfriend, or classmate to help you finish your homework; do your homework tonight and turn it in the next time the class meets; or finish your homework first then show up late for class." There are many more answers to this problem, and all of them are legitimate.

Now turn the page, take your time, have fun, and remember to give as many ideas as possible for what to do about your forgotten homework.

Example Problem 2

Your friend Pat sits next to you in class. Pat really likes to talk to you and often bothers you while you are doing your work. Sometimes he distracts you and you miss an important part of the lecture, and many times you don't finish your work because he is bothering you.

What should you do? How would you solve this problem? Remember to list as many ideas and solutions as you can.

Example Problem 3

It's a great day for sailing, and your buddy, Kelly, comes to work and asks you if you want to go sailing. Unfortunately, you have a big project due tomorrow, and it requires a full day to complete. You would rather be sailing. What are you going to do? Think of as many alternatives that would allow you to go sailing as you can!

Advantages and Disadvantages

There is a trade-off with realistic tasks. They may motivate some examinees because they are realistic. Some examinees may not be all that interested in expending effort for tasks that are not realistic, such as listing uses for a brick. These examinees might be more interested in realistic tasks, such as listing excuses for not having completed homework! Then again, divergent thinking tasks are quite sensitive to the testing setting, conditions, and instructions, and Originality is the most likely when testing occurs under game-like conditions, when examinees are told that the tasks at hand are not tests and that there is no time limit, nor correct or incorrect answers. They can be told to have fun, take their time, and to be creative—and originality is very likely. And recall the need for time to find remote associates, which means that several minutes (e.g., five or six) should be given for each task. Ideally examinees should be told that they have as much time as they like. This will both allow remote associates to be found and let examinees know that the tasks are not like academic tests.

The trade-off mentioned just above arises because realistic tasks might be more constrained than the standard tasks, such as Instances or Uses. If this is the case the order of administration might be manipulated such that generalization to the natural environment is more likely. The order might begin with standard tasks, which are wide open, and then move to realistic tasks, which suggest that divergent thinking can be applied to problems found in the natural environment. This would be another way to use the fading method, which was mentioned earlier.

Importantly, the rCAB battery contains divergent thinking tasks that reflect an examinee's ability to generate problems (rather than solutions). These are, then, *problem generation* or *problem discovery* tasks rather than problem solving in response to presented problems. Problem generation tasks are open ended and can be scored for Fluency, Originality, and Flexibility. They can be used in conjunction with standard divergent thinking tasks to obtain a more general profile of an individual's ideational skills. Problem generation divergent thinking tasks are theoretically justified by the fact that creativity requires more than problem solving. Sometimes solving the problem is not the difficult thing; defining it might be more difficult. Problem generation divergent thinking tasks estimate what is often called problem finding ability.

The problem generation scores derived from divergent thinking tests may be important for certain clinical predictions. For example, the interaction between problem generation and problem finding was found to be highly related to suicide ideation. In particular, suicide ideation was related to the interaction between (high) Fluency scores on problem generation tasks and (low) Flexibility scores on problem solving tasks. This interaction was expected because it indicates that the individual is aware of many problems (as seen in his or her Fluency) but not aware of many different solutions (as seen in the low Flexibility). Significantly, this interaction between problem generation and problem solving was more strongly related to suicide ideation than depression measures, which are typically quite respectable predictors of suicide ideation.

There are other important aspects of creative problem solving, in addition to problem finding and solution (idea) generation. Solution evaluation is also very important. Some persons seem to know an original idea when they have one, while others do not. Runco and his students developed various reliable measures of idea evaluation and found that it can be reliably assessed and that idea evaluation is only moderately correlated with idea generation (Runco and Smith, 1992). More will be said about idea evaluation later in this entry.

Psychometric Issues

The most critical psychometric issue when testing divergent thinking—or any aspect of creative cognition—is discriminant validity. This relates to the distinctiveness of divergent thinking. Is it distinctive or does it overlap with other forms of ability? Is it related to IQ? Can we predict divergent thinking ability from measures of traditional intelligence?

Answers to these questions varied in the 1960s. In one seminal investigation Michael Wallach and Nathan Kogan administered divergent thinking tests under conditions that were dramatically different from the conditions typical of testing. They were the ones that first demonstrated the importance and advantages of game like testing conditions. They told the examinees – school children – that the divergent thinking tests were games, and they avoided referring to the tasks as tests. They allowed a great deal of time and were explicit about the need to generate a number of responses (rather than one correct response). Under these conditions the divergent thinking tests did display more than adequate discriminant validity. Previous research had administered divergent thinking tests under test-like conditions and discriminant validity was not good at all. It seems to require the right testing conditions.

The issue of discriminant validity is important in a practical sense because it indicates that divergent thinking tests provide information that would otherwise be unavailable. In behavioral terms it means that if schools rely on tests of traditional ability they will overlook children who have outstanding divergent thinking abilities (but only moderate or even low IQs and academic aptitude).

The relationship of divergent thinking with IQ and traditional intelligence seems to vary at different levels of ability. There may even be a threshold of intelligence that is necessary for creative ideation. This would make sense because some basic information processing capacity is necessary for associative and divergent thinking. Additionally, many tests of divergent thinking require that the examinee has some basic knowledge, and that too suggests a modicum of traditional intelligence. Logically creative problem solving probably depends on both creative cognitive capacity but also strategy and knowledge.

The ‘threshold theory’ suggests that some traditional ability is necessary for effective divergent thinking. The early estimates were an IQ of approximately 120, but this figure is probably just about meaningless, in part because the average IQ in the population is on the rise. Then there are the questions about the validity of the IQ. Still, the concept of a threshold does make good sense, even if we cannot pinpoint a specific IQ.

The threshold may be viewed graphically, as would be the case if divergent thinking scores were plotted as a function of IQ levels. When this is done a triangle of data points appears in the bivariate scatterplot. The top of the triangle is pointed at the origin of the graph, with the scatter of data spreading as IQ levels increase. If that same scatterplot is bisected perpendicularly to the *X* axis (and at the hypothetical threshold) and also bisected perpendicularly to the *Y* axis, four quadrants are formed. Empirical studies find some persons in the first quadrant, with low divergent thinking and low IQ. There are also persons with high IQs and low divergent thinking. There are a few persons with high divergent thinking and high IQ, but no one with low IQ and high divergent thinking. This triangular distribution supports the idea of a minimum threshold of IQ which is necessary but not sufficient for divergent thinking. Research from Runco and Albert (1986) and, more recently, from Jauk et al. (2013) suggests that the threshold may vary from index to index, with one threshold for fluency and another for originality. Correlations also vary depending on the measure of convergent thinking used.

There are persons with high IQs and low divergent thinking, which again supports the discriminant validity of the divergent thinking tests. It also suggests that individuals who are extremely good at the convergent thinking and memorization required for exceptional IQs may be at a serious disadvantage for divergent thinking and creative thinking. They may only be able to think of conventional ideas and are unable to generate original ideas.

A second critical issue is that of the predictive validity of divergent thinking tests. Here again, results have been quite varied. This is not much of a surprise, however, given that creativity can be expressed in so many different domains. Moreover, divergent thinking tests do not guarantee actual performance any more than any other controlled assessment offers any guarantees. As noted above, divergent thinking tests are estimates of the potential for creative thought, and actual creative problem solving requires other things (e.g., attitude, problem finding, idea evaluation, motivation).

The biggest obstacle in this area of research is the *criterion problem*. There is no widely accepted and universally applicable criterion of creative performance with which to give divergent thinking tests (or any other test of creativity) a fair evaluation. Divergent thinking tests have demonstrated only moderate, and sometimes disappointing, predictive validity. When fluency, originality, and flexibility are all taken into account, predictive validity coefficients have reached 0.55. There is also impressive longitudinal data with predictive validity coefficients of approximately 0.30, with certain criteria—over a 50 year interval. Some of the newer research uses a criterion called the RIBS (*Runco Ideational Behavior Scale*), which was designed specifically for the testing of divergent thinking and focuses entirely on ideas. When it is used both the predictor (the divergent thinking test) and the criterion (the RIBS) focus on ideas, and not surprisingly, the correlation is quite reasonable.

Divergent Thinking and Idea Evaluation

Divergent thinking tests assess how well people generate ideas. As mentioned briefly above, the generation of ideas is, however, only one part of creative thinking. It is very important to be able to judge ideas, as well as generate them. Further, for creative thinking it is also necessary to judge ideas specifically for originality. Some kind of critical thinking may allow an individual to recognize whether or not an idea will solve a problem, but this is a very different thing from recognizing originality. There is, then, a difference between valuation (seeing the originality of an idea) and evaluation (seeing the effectiveness of an idea). A series of studies suggests that both of these are correlated with, but far from identical with, traditional divergent thinking indices. Hence someone can do one but perhaps not the other. Someone can generate ideas but not judge them accurately, or vice versa. There is also a difference between inter- and intrapersonal judgmental accuracy, but disappointingly, in both cases the accuracy is below 50%. In other words, original ideas are recognized as such less than half of the time! These findings of only moderate judgmental accuracy have been used to support the theory that creative thinking is more blind (or random, to use the Darwinian label) than guided.

Conclusions

Divergent thinking tests are grounded in sound theory. In particular, both associative theory and Guilford's own SOI model support the use of divergent thinking tests. Their use in research has generated many interesting results. Divergent thinking has been used in studies of the fourth grade slump, for example, and in investigations of the relationship of creativity with suicide ideation. Much of this research is reviewed in other entries in this encyclopedia. The corpus of research on divergent thinking is advantageous in the sense that the strengths and weaknesses of these tests are well known. Interpretations of test results are fairly straightforward, given the large literature on divergent thinking. Another strength is the practicality of the tests. They can be used in various settings (e.g., educational, clinical, and organizational) and can be used as exercises or assessments. As noted above, when used as assessments, they are best viewed as estimates of the potential for creative thinking and problem solving.

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Diversifying Experiences

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General Introduction

Imagine sitting in your favorite restaurant—you come here often so you know the place well. In the restaurant, business is going as usual. You brought your daughters, who are sitting at the table playing with a toy car. When the waiter comes back with the bottle of water you ordered, he gets distracted, and puts the bottle on the edge of the table. At the same time, the toy car slips out of your daughters's hands, slides towards the bottle, and knocks it over. Against all expectations, the bottle does not fall on the ground, but slowly moves towards the ceiling. You are stunned. You did not expect this to happen, nor did you think this ever could happen.

In an experimental study conducted in virtual reality, participants experienced this exact situation—a bottle moving up instead of falling down after being knocked over by a toy car. As a result, participants showed a more creative thinking style.

Experiences like these are called 'diversifying experiences'. They are unusual and unexpected events or situations that push people outside of the realm of normality. Research has shown that diversifying experiences, such as violations of expectations, mental or developmental adversity, and multicultural experiences, can elicit a more flexible way of thinking and are related to higher levels of creativity.

Schema-Violations

Diversifying experiences can push people outside of the realm of normality; this happens when people witness or experience targets, objects, or actions that are inconsistent with their expectations about the world. Diversifying events of this kind are called 'schema-violations'—events or experiences that disconfirm schema- and stereotype-based expectancies. When people have to navigate through a situation that is new and rather challenging, previously used schematic solutions no longer apply, making it necessary to look for alternative answers. Hence, new and alternative ways to solve problems are investigated, thereby increasing the chances of creativity and of embracing atypicality.

Contradictory or Paradoxical Information

Experimental studies have shown that schema-violations can be induced relatively simply by asking people to write down, or merely read, seemingly contradictory or paradoxical statements. For example, in one study, participants read a description of a problem, yet halfway through the description suddenly the information provided became inconsistent with the rest of the description. Creative ability was higher after reading these inconsistent descriptions, compared to descriptions that did not include inconsistencies. Interestingly, however, this effect was only found for people with high levels of problem construction ability, indicating that the ability to define problems in multiple, creative ways may be necessary to process this diverse or conflicting information.

In similar vein, after reading a product description that contained paradoxical information, creativity was enhanced relative to when the description contained only compatible information (Miron-Spektor et al., 2011). The latter effect also held when

people, instead of merely reading the paradoxical statements, actively formulated them themselves. In that case, the effect seemed to be mediated by both implicit and explicit sense of conflict associated with the paradox. Still another study showed that creativity is enhanced more after combining two concepts with many incompatible attributes. Participants had to solve either novel or ordinary conceptual combination problems. An ordinary combination included two concepts with many compatible attributes, like a piece of coat that is also a kind of animal skin (a leather jacket). A novel combination included two concepts with many incompatible attributes, like a piece of furniture that is also a kind of fruit (e.g., a banana-shaped sofa-bed), requiring participants to actively resolve the incompatibilities between the emergent properties of the concepts. In line with other studies on contradictory or paradoxical information, creative performance only improved after solving novel (as opposed to ordinary) conceptual combinations.

Counter-Stereotypes

Counter-stereotypes are another type of schema-violations that have the potential to influence creativity. For example, it has been shown that listing counter-stereotypic social category combinations (“overweight model”), as opposed to stereotypic social category combinations (“skinny model”), can lead to higher cognitive flexibility, less heuristic, and more indirect, to creative thinking (Godłowska et al., 2013). Furthermore, studies have shown that witnessing individuals in a counter-stereotypic environment can influence performance on creativity measures. That is, after looking at pictures of individuals in an unexpected environment (e.g., a priest in front of a mosque), creativity was higher than after looking at the same individuals in their expected environment (e.g., a priest in front of a church; Godłowska et al., 2014). Interestingly, studies suggest that the relationship between counter-stereotypes and creativity depends on personality factors such as personal need for structure, with only participants low in personal need for structure experiencing a creativity boost after being confronted with schema-inconsistencies. In line with these findings, using a task in which participants consistently indicated their preference for either a schema-consistent or schema-inconsistent image, both participants low in need for structure and high in openness to experience exhibited a higher preference for (i.e., likability) and approach tendency towards the counter-stereotypic, schema-violating pictures.

Real-Life Schema-Violations

Besides reading or writing paradoxical stories or statements like the ones mentioned above, or looking at pictures of counter-stereotypic events or environments, one can also experience schema-violations in real-life. Imagine, for example, that you just moved to another house, and it is your first time driving to work from your new home. Whereas earlier you could almost automatically drive to your work, now you have a little trouble finding your way. That is, your existing schema of how to get to work is almost completely based on the old route to work you drove so many times for years. Now, however, the route you are driving is inconsistent with this schema, and you are forced to adjust. Do creativity and levels of creative performance also enhance after these real-life schema-violating events? Several studies suggest they do.

It is argued that at times, perhaps in service of a specific goal (e.g., maintaining social relationships), humans are able to display bodily expressions that are contradictory to their mental states. In doing so, individuals experience a sense of incoherence indicating to the person that the environment is unusual, and that alternatives have to be considered. For example, normally, happy facial expressions originate within happy circumstances. However, when, for whatever reasons, sad facial expressions accompany happy circumstances, a sense of incoherence is experienced. Hence, individuals experience themselves in a schema-violating manner. Therefore, in testing whether this so-called ‘mind-body dissonance’ would subsequently improve levels of creativity (or embracing atypicality), Huang and Galinsky (2010) conducted four experiments, in which they either paired happy and sad memories or music with happy and sad facial expressions, or paired high- and low-power roles with high- and low-power postures. In doing so, they were able to show that mind-body dissonance stimulates people to flexibly expand their category boundaries, which can aid in creative problem solving.

In another study investigating real-life schema-violations, Ritter et al. (2012) had participants prepare a sandwich with butter and chocolate chips (a popular breakfast in the Netherlands) either in a well-known, routinely manner, or in a rather unusual, schema-violating way. Whereas those in the routine condition buttered the bread and then sprinkled the chocolate chips on top of the buttered bread, participants in the schema-violating condition first sprinkled the chocolate chips on a plate, buttered the bread, and then placed the buttered bread upside down on the plate full of chocolate chips. Those individuals who had prepared their sandwich in a schema-violating way demonstrated higher levels of cognitive flexibility on a subsequent task, compared to individuals who had followed their normal routine in preparing their breakfast.

In the same line of studies, Ritter et al. (2012) had participants experience even more rigorous schema-violations—violations of the laws of physics. While being immersed in virtual reality, participants either experienced three laws of physics (perspective, velocity, and gravity) being violated, or experienced the same events in a non-violating way. To be more specific, in the schema-violation condition objects became smaller in size while participants were approaching them, time seemed to fly (i.e., 1 step in virtual reality equaled a 2.5 change in environment), and instead of falling of a table as expected, a bottle slowly moved upwards in the air. Individuals who had experienced these intense and immersive schema-violations demonstrated a more flexible thinking style on subsequent measures of creativity, as compared to those who had experienced the corresponding normal events.

The examples described above suggest that schema-violations can arise in virtually every situation, ranging from being exposed to paradoxical information or counter-stereotypes, to disrupting a routine activity, to taunting the laws of physics. These

situations—as diverse as they are—have in common that people experience or witness something that is inconsistent with their expectations, hereby forcing them to embrace atypicality and to look for alternative answers. This can elicit a more creative thinking style. The question remains what the boundary conditions are of the relationship between schema-violations and creativity.

Boundary Conditions

Does every schema-violation facilitate creativity? Are there differences between various types of schema-violations and their influence on creativity? Do schema-violations always have a positive influence on creativity, or may the relationship sometimes be reversed? In the following section, different features of schema-violations will be discussed that may have an influence on creativity: intensity, valence, and level of engagement.

Intensity of schema-violations. As illustrated above, irrespective of their intensity, schema-violations can have an effect on creativity. That is, starting with smaller, weaker schema-violations such as reading paradoxical information, to bigger violations such as coming up with counter-stereotypes and violation of routines, to the biggest violations when the laws of physics are taunted, all studies seem to indicate the same: an improvement in creativity.

Valence. Whereas the schema-violations described above are relatively neutral (e.g., they are not particularly threatening), there are examples of schema-violating situations that have a negative valence. For example, in one study, participants witnessed a person being rude to another person—an act that can be considered as schema violating. Subsequently, levels of creativity decreased, rather than increased. However, this effect was mediated by negative affect. The authors argue that the negative affect caused a deficiency in encoding elaboration, thereby negatively affecting creativity. Perceiving a schema-violation as negative or threatening may, thus, have detrimental as opposed to beneficial effects on creativity.

Level of engagement. Another interesting feature of schema-violations involves the fact that they can be passively witnessed or actively experienced, leading authors to suggest that the relationship between schema-violations and creativity may partly depend on the level of engagement one has with the experience. The two studies of [Ritter et al. \(2012\)](#) described above (in which participants prepared a sandwich in a schema-violating order, and experienced the laws of physics being violated) also included a passive condition, in which participants did not experience the schema-violation themselves, but witnessed a film-clip of an actor encountering the schema-violation. Increased creative thinking was observed after active involvement in schema-violations or unusual events, but not after vicarious involvement (i.e., when simply witnessing a schema-violation or an unusual event). Moreover, [Ritter et al. \(2014\)](#) showed that participants' levels of cognitive flexibility increased after witnessing a film clip of an actor performing a sequence of actions in a rather unusual, schema-violating order (compared to a well-known order) but only when identification with the actor was high (i.e., when being immersed in the story, and when identifying with the actor performing the action). When identification with the actor was low (i.e., when merely focusing on evaluating the story and the performance of the actor), witnessing schema-consistent versus schema-violating sequences of actions did not influence creativity. These findings suggest that at least some level of engagement in a schema-violation is necessary for creativity to be enhanced.

Why Schema-Violations Influence Creativity

Although less is known about the theoretical understanding of the effects of schema-violations on creativity, authors have suggested that the experience of conflict or violation of expectations that arises with schema-violations, and/or a persons' ability to differentiate and integrate multiple perspectives (i.e., integrative complexity), can mediate the effect.

For example, research testing the effect of a conflict mindset on creativity has shown that when adopting a conflict (versus cooperation) mindset people develop more original solutions for conflict-related situations. Furthermore, adopting a paradoxical frame elicited a sense of conflict regarding this frame, both explicitly and implicitly, which subsequently accounted for its relationship with creative insight. In a similar experiment, participants also performed a writing task in which they were asked to write a story describing a picture. Used as a measure of integrative complexity, these stories were subsequently rated on the use of different or competing themes, and the connections between these themes. Results showed that adopting a paradoxical frame indeed increased participants' ability to differentiate and integrate multiple perspectives, and that this ability, together with sense of conflict, accounted for the relationship with creativity. Moreover, a study investigating the neural correlates of schema-violations has shown that activity in the temporal parietal junction (TPJ)—a brain region known to be involved in violations of expectations and unexpected environmental stimuli—was higher for participants who were watching a schema-violating event compared to participants who were watching the corresponding normal event ([Ritter et al., 2014](#)). Additionally, activity in the right TPJ was positively correlated with an increase in cognitive flexibility. These results indicate that schema-violations may enhance creativity because they break expectations, thereby enabling people to overcome mental fixedness.

Developmental Adversities

Another diversifying experience that can push people outside of the realm of normality and help them see the world in multiple ways may be the experience of developmental adversities. Especially research into the non-normative life experiences of eminent artists speaks to this idea, showing that diversifying experiences of artists may play a significant role in later creativity.

For example, in studies focusing on eminent creators, creative performance seems to have a negative relationship with psychological health (Simonton, 2014a), and eminent achievers in several domains appear to exhibit higher levels of psychopathology compared to the general population. As suggested by Simonton (2014a), the productivity levels of creative artists and ‘geniuses’ correlate positively with the incidence of mental problems. Notably, through extensive historiometric analyses, Damian and Simonton (2015) argued that, besides mental illnesses, more developmental adversities are also related to more lifetime creative achievement, but that this effect has been relatively overseen because most studies use samples with relatively few developmental adversities (i.e., majority samples). Therefore, based on analyses of biographical sketches of eminent African American achievers, these authors showed that the positive relationship between mental illness and creative achievement diminished when controlling for developmental adversity (parental death, poverty, and discrimination), indicating that developmental adversity had traded-off roles with mental illness as a diversifying experience in enhancing creativity. Importantly, it may not merely be mental illness or psychopathology, but instead, more general adversities during development, that can act as diversifying experiences in enhancing creativity. For example, archival research showed that eminent individuals experienced more demanding childhood experiences compared to an ordinary sample. Additionally, eminent creativity has been linked to experiences such as early orphan hood, being part of a minority group, or having had unconventional education.

Multicultural Experiences

Multiculturalism

Another type of diversifying experience that can influence creativity is experiencing multiculturalism, or multicultural experience. When people learn how things are done differently in other cultures, they are pushed outside the realm of normality, thereby increasing their chances of seeing things from multiple perspectives, thus stimulating flexible, creative thinking (Gocłowska and Crisp, 2014).

Multicultural experiences and their influence on creativity range widely. For example, recreational travel seems to increase creativity (De Bloom et al., 2014), but also working together with culturally heterogeneous groups causes a steeper increase in creativity as compared to working in homogeneous groups (particularly when the differences between groups are not made salient; Vezzali et al., 2016). Furthermore, membership in multiple groups is associated with greater creativity. Importantly, multiple studies on counter-stereotypes demonstrate that even thinking of diverse individuals can elicit higher creative performance (Gocłowska et al., 2013).

Multicultural Experience Survey

Leung and colleagues have developed the Multicultural Experience Survey (MES; Leung and Chiu, 2010), a questionnaire including items on living abroad, speaking foreign languages, and one’s immigration status, but also on one’s favorite cuisine (foreign or not) and the nationality of one’s favorite musicians and closest friends. Interestingly, higher levels of multicultural experiences, as indicated by higher scores on the Multicultural Experience Survey, are related to higher levels of creativity, and this relationship seems to be particularly true for individuals high on the personality trait openness to new experiences. On the other hand, for those individuals who are less open to new experiences, the relationship between multicultural experiences and creativity seems to be reversed.

Living Abroad

Another type of multicultural experience is the experience of living abroad. Studies have shown that people who have lived abroad achieve greater creative and professional success compared to individuals that have spent their whole life in the same country. This link specifically accounts for individuals who identify with both their home and host cultures simultaneously, compared to those who only identify with a single culture, presumably because the former have greater levels of integrative complexity—the ability to consider and combine multiple perspectives. Similarly, in an experimental study, being exposed to elements of two cultures simultaneously led to bigger increases in creativity than being exposed to elements of either culture separately (Leung and Chiu, 2010).

One critical aspect of the relationship between exposure to foreign cultures and creativity seems to be multicultural learning—learning about the host culture. One longitudinal study found that the extent to which MBA students learned about the culture of the country they moved to, predicted their ability to differentiate and integrate multiple perspectives, which subsequently predicted the number of job offers they got after graduation (Maddux et al., 2013). Furthermore, for those individuals who moved abroad, the relationship between time spent abroad and creativity was significantly mediated by adaptation—that is, the extent to which they learned how to behave and think in a different way (Maddux and Galinsky, 2009). Similarly, compared to learning something new about your own culture, creativity seems to increase more after learning something new about another culture, especially when the underlying reasons are also known.

In sum, a host of studies has demonstrated how identifying with, learning about, and adapting to multicultural experiences are related to creativity. That is, the diversifying experience of living abroad, or gaining multicultural experience, can broaden one’s view, and enable to literally and figuratively see multiple perspectives, thereby facilitating our creative thinking skills.

Are All Diversifying Experiences Positive?

Although most research focuses on the positive link between diversifying experiences and creativity, it is important to keep in mind that sometimes and some types of diversifying experiences can backfire—they can have a negative relationship with creative performance (for reviews see [Damian and Simonton, 2015](#); [Gocłowska et al., 2018](#)). One reason why this might happen is because when diversifying experiences are very intense, individuals may lose the ability to cope with those experiences. For instance archival analyses of the lives of great fashion designers revealed that some aspects of multicultural experiences, like the number of countries that one has visited, or the extent of cultural differences between these countries, have a curvilinear, inverted U-shaped link with creativity. These analyses revealed that while at low-to-medium levels of intensity multicultural experiences would benefit creativity, once a certain level of intensity was reached the relationship with creativity began to taper off or even reverse. A similar pattern has been suggested in archival research looking at how mental illness and racial minority status affected creativity of eminent African- and White-Americans ([Damian and Simonton, 2015](#)), and in research on mental illness among famous thinkers, writers, artists and composers ([Simonton, 2014a](#); for reviews see [Damian and Simonton, 2015](#); [Gocłowska et al., 2018](#)).

As a result, [Gocłowska et al. \(2018\)](#) postulated that the beneficial effects of diversifying experiences to creativity may be bounded by the intensity of diversifying experiences, as well as the personal coping resources available to individuals undergoing those experiences. Diversifying experiences of low to medium intensity should primarily be perceived as challenging, thereby increasing creativity, however diversifying experiences of medium to high intensity are more likely to be perceived as threatening, thereby decreasing creativity. Furthermore, the “sweet spot” at which diversifying experiences benefit creativity may vary from one person to another, and from one situation to another. With high personal adaptive resources individuals undergoing diversifying experiences are more likely to appraise those experiences as a challenge, thereby increasing creativity, whereas with low personal adaptive resources, they are more likely to appraise the same diversifying experience as a threat, thereby decreasing creativity. Hence, according to the diversifying experience model, the effects described in the current article may be bounded by diversifying experience intensity as well as individual’s coping resources.

Conclusion

In sum, diversifying experiences—unusual and unexpected events or situations that push people outside of the realm of normality— can elicit a more flexible way of thinking and are often related to higher levels of creativity. When people experience new and rather challenging situations, previously used schematic solutions may no longer apply, making it necessary to look for alternative answers. Hence, new and alternative ways to solve problems are investigated, thereby increasing the chances of higher creative performance. One type of diversifying experience that can arise in virtually every situation are schema-violations. Schema-violations can range from encountering paradoxical information, to being exposed to counter-stereotypes, to disrupting a routine activity. These situations, as diverse as they are, have in common that people experience or witness something that is inconsistent with their expectations, hereby forcing them to embrace atypicality and to adapt a more creative thinking style. Research has identified several boundary conditions of the relationship between schema-violations and creativity. For example, at least some level of engagement in a schema-violation is necessary for creativity to be enhanced. Moreover, perceiving a schema-violation as negative or threatening may have detrimental as opposed to beneficial effects on creativity. Developmental adversity (e.g., poverty, discrimination, early orphan hood, being part of a minority group, having an unconventional education) is another type of diversifying experience that can influence creativity. Especially research into the non-normative life experiences of eminent individuals speaks to this idea, showing that diversifying experiences of eminent individuals may play a significant role in later creativity. Moreover, diversifying experience can be elicited by multicultural experiences. Multicultural experiences and their influence on creativity range widely, from recreational travel, to working together with culturally heterogeneous groups, to living abroad. What they have in common is that people learn how things are done differently in other cultures, and they pushed people outside the realm of normality, thereby increasing their chances of seeing things from multiple perspectives, thus stimulating flexible, creative thinking. On the one hand, capturing all unusual and unexpected situations under the umbrella term diversifying experiences allows us to realize that a whole range of very different phenomena (extending even further than schema-violations, developmental adversities and multicultural experiences) are in one way or another linked to creativity and creative performance. On the other hand, however, it is important to keep in mind that every situation is unique, and therefore may have its own unique influence on creativity. Moreover, the relationship between diversifying experiences and creativity is not a static given, but may depend on the intensity, valance, and level of engagement with the situation.

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Diversity

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Glossary

Bicultural Bicultural individuals have experienced and internalized two cultures

Closed-mindedness The need to have a certain answer

Cognitive flexibility The ability to engage multiple concepts simultaneously and adapt behavior to one's environment

Essentialism The view that women and men, or different racial groups have specific "essences" that make them what they are.

Integrative Complexity A high level of differentiation and integration of a plurality of perspectives

Diversity Definition

The term diversity refers to difference, and in this context a diverse system is one in which human beings that have been categorized as different from each other coexist. Common categories include race, gender, class, culture, ethnic origin, religion, and sexual orientation. Other relevant forms of diversity include cognitive diversity, and importantly diversity in attitudes toward diversity. Where diversity refers to the demographic fact of differences, pluralism is the intentional effort to engage diversity to create a mutually beneficial, generative social system.

Introduction

The relationship between creativity and diversity is complex. Historically cultural diversity has been a primary engine of innovation (Zachary, 2003). More mundanely, diverse groups come up with more uses for a brick than homogeneous groups. Culturally diverse groups also come up with more ways to prepare a chicken, whether Tandoori Chicken, Chicken Kiev, Pollo en Mole, or Pollo al Mattone, an Italian preparation involving a chicken flattened by, appropriately, a brick. Diversity can lead to creativity, but it can also lead to conflict and fragmentation. The term diversity is notably used in the context of prejudice, racism, systematic oppression, bias, and the "diversity trainings" created to address them. The creativity of diversity is by definition a social, interactive creativity, a multidimensional phenomenon that has psychological, interpersonal, and cultural dimensions. In order for diversity, understood broadly as demographic difference, to lead to creativity, it requires an intentional effort to find mutual understanding, bridge and leverage differences and remain open to the possibility of creation.

Diversity: Source of Problems and Source of Creativity

In the mid-20th century, humanistic psychologists like Abraham Maslow drew attention to the fact that the discipline of psychology had focused on humanity's pathological manifestations (what was sometimes referred to as "aggression and depression") but was much less knowledgeable about psychological health, well-being, and creativity. The focus on psychological health and optimal functioning was later followed by Positive Psychology. In the same way, the Indian political psychologist Ashis Nandy has pointed out that there is a "conspicuous asymmetry" between studies focusing on violence and those focusing on creativity or non-violent exchanges between different cultures and ethnicities (Nandy, 2002). Some media present dramatic stories of violent clashes

between groups, extremist over moderate voices, and tend to focus on violence. Creativity in the study of culture and religion can still be found in current affairs and in the research and practices of diversity.

One of the key problems facing the global discourse of diversity is that it is increasingly framed as a *problem*, and at best a problem to be managed (Montuori and Stephenson, 2010). The growing crisis of immigration, with refugees fleeing war zones, political and ethnic persecution and economic hardship has put a strain on some countries and has been one source of this approach. At the same time there has been a rise in authoritarian leaders around the world. Historically such leaders have used propaganda to demonize out-groups, often for the purpose of bringing a group or a nation together under the pretense of fighting a common internal or external threat. Authoritarianism always involves attempts to homogenize, hierarchize, and set up black and white alternatives, setting in-group against out-group. Around 60% of Americans believe the presence of people of different races, ethnic groups, and nationalities makes the United States a better place to live.

In organizations, diversity trainings attempt to instruct people in how to avoid being insensitive, abusive, stereotyping, offensive, and how not to break the law. There is greater awareness of the pervasiveness of racism, sexism, and prejudice based on sexual orientation and gender identity and bias toward other cultures and out-groups, and of incidents of prejudice. Thus it is perhaps not surprising that there is more emphasis on highlighting persistent and inexcusable injustice. The focus is on individual and collective problematic attitudes and behaviors and what can be done to avoid them. Nevertheless, the two dominant approaches to issues of diversity in the United States, “colorblindness” and multiculturalism, make both minorities and non-minorities feel excluded they have been found to be largely ineffective (Kalev et al., 2006; Plaut et al., 2018).

The real and the potential benefits of diversity, the articulation what a thriving diverse society or organization might be like, and the propagation of examples from history to illustrate how the creativity of diversity has fueled human flourishing have not received the attention that racism, sexism, and other forms of discrimination have. There is scant popular awareness of the historical role of creative diversity in such key places and times such as The Gupta period of India, Periclean Athens and the rich culture of the Mediterranean, the reign of the Kangxi emperor, Florence in the Renaissance, Al-Andalus, the Silk Road, the exchanges across the Indian Ocean, Vienna at the turn of the 20th century, and many other significant examples of cultural creativity. While certain places and times have been recognized and studied as particularly significant moments in human history, creativity research has not engaged with them extensively. Indeed, creativity researchers have only recently begun to address the complexities of social and cultural creativity (Simonton, 2003).

Disciplinary fragmentation has meant that research on the interaction of creativity, culture, and diversity can be found scattered in a wide range of disciplines such as Cultural Studies, Ethnic Studies, Women’s Studies, and History. These disciplines are often not informed by what is traditionally known as creativity research as documented in this encyclopedia. Creativity research is in a position to make a substantial contribution to the discourse and practices of diversity, and the challenge of diversity also involves diversifying creativity research itself by making it more transdisciplinary, in dialog with a range of other disciplines, and with a more diverse cast of researchers. A brief overview of creativity and diversity in groups and culture gives a sense of the range and scope of the existing research and the opportunities that lie ahead.

Groups and Cultures

In the United States historically groups were frequently associated with the phenomenon known as groupthink, which is in fact quite antithetical to creativity (Janis, 1983). Creativity was associated almost exclusively with individuals, which meant relationships and exchanges were not researched. Research on creativity in groups is a relatively recent phenomenon sparked to some extent by the interest in creativity and innovation in industry where the value of creative groups is great. The study of creative groups in jazz and more generally in the arts has also contributed to the development of this field (Sawyer, 2006) (See Teams).

The phenomenon of groupthink is particularly interesting because it involves a number of factors, all of which conspire to homogenize the group, eliminate diversity of perspectives and creativity. They include:

- The unwillingness to examine anything but a few alternative courses of action, often only two, without a survey of the full alternatives;
- Failure to examine the course of action initially preferred by the majority of the members from the standpoint of non-obvious risks and drawbacks that had not been evaluated originally;
- Neglect of courses of action initially evaluated as unsatisfactory by the majority;
- Little or no time is spent discussing whether non-obvious gains have been overlooked or whether the ways of reducing seemingly prohibitive costs which make alternatives undesirable;
- Few if any attempts to obtain information from experts who can supply sound estimates of losses and gains to be expected from alternative courses of action;
- Selective bias is shown in the way the group reacts to factual information and relevant judgments from experts, the media, and outside critics;
- Members take interest in facts that support their initially preferred policy, and take up time in their meetings to discuss them, but they ignore facts and opinions which do not support their policy;
- Members spend little time deliberating about how the chosen policy might be hindered by bureaucratic inertia, sabotaged by political opponents, or temporarily derailed by the common accidents that befall the best of plans.

Groups that become victims of groupthink have already made up their minds and are unwilling to listen to any other views. There is a pressure to conform and go along with the group consensus. In terms of the creative process, they cannot accept divergent thinking, because they have already converged on the right policy or plan. Victims of groupthink therefore eliminate creativity altogether to the extent that no diversity of perspectives or alternatives are encouraged. The group process to some extent displays processes that occur at the individual level but writ large. "Premature closure," or the unwillingness to explore alternatives after the initial diagnosis, is the most common error in medical diagnoses, for instance. Minority dissent on the other hand stimulates creative thinking, as does an insistence of maintaining a diversity of perspectives in the group (Nemeth, 2018).

There are many ways that diversity fosters creativity. A diversity of background, knowledge, and perspectives enhances creativity in groups. The presence of group-members with diverse perspectives can lead to more creativity and problem-solving ability than a group of experts. A dramatic example occurred when Eli Lilly created a Website where members of the public could engage with scientific problems that the company's researchers were facing. The company promised a financial reward for the solutions to the problems, which ranged from breast cancer risk assessment to the detection of organic chemical vapors to tracing metal impurities (Page, 2008). The success rate of this approach was remarkably high, and now open-sourced and distributed problem-solving have become significant sources of innovation. The reason why they work is because when problems are complex, diversity trumps ability.

Teams can have cognitive differences, which is one form of diversity. These differences can include different perspectives, or ways of representing situations or problems; different interpretations, or ways perspectives are categorized; diverse heuristics, or ways of creating solutions for problems; and diverse predictive models, which address cause and effect. A positive atmosphere, and an absence of relational conflict are important, but challenges and stress are also needed to bring the best out of the group. Differences of perspective can lead to conflict, and yet it is not the content of the conflict that is most important but the way it is addressed. In fact, conflict can even be generative, and lead to more creativity. In order to be creative, diverse groups have to be creative about their diversity and about how they get along. Cultural and more broadly demographic diversity can also be beneficial for group creativity. In order for demographic diversity to be beneficial, the group needs to be motivated to make it work and needs to work together to create trust. Having respect for the ability of others is an important factor in establishing a foundation for diverse groups. This takes us back to the difference between diversity, which refers to the fact of diverse elements in any system, and pluralism, the intentional effort to engage diversity to create a mutually beneficial, generative social system. The creative group or organization or society is itself a creation (See Group Creativity).

Creative groups are marked by paradoxical relationships found in the form of both/and creative tensions. R&D scientists for instances have been shown to want autonomy *and* interaction, specialization *and* broad interests, the pursuit of interested problems for their own sake *and* practical results. Belbin's work addresses the importance of experiential diversity in groups and proposes a specific set of roles in a group facilitates the creative process. The roles are the Plant (or Idea-generator), The Shaper who shapes and drives the process, The Resource Investigator who finds and mobilizes resources, The Coordinator, who ensures equitable participation, The Specialist, who brings technical knowledge, The Monitor-Evaluator, who acts as critic, The Implementer who focuses on the product, The Completer-Finisher who acts as the detail person, and the Team-Worker who maintains morale and cohesion (Belbin, 2012). Whether or not groups actually include the broad range of diverse perspectives, roles, and aptitudes Belbin suggests, his research indicates that the right mix of diverse experiences and capabilities is helpful in a group.

Diversity has consistently contributed to musical innovation. Port cities from Lesbos to Liverpool, New Orleans, Havana, Kingston, Rio de Janeiro, Salvador da Bahia, and Venice have always been centers of musical innovation (Gioia, 2019). A multicultural mix has always led to a thriving musical scene. Port cities and multicultural communities have always benefited from the exchange of people and ideas, from traffic, visitors, and ideas. Simonton (Simonton, 1997) summarized this by writing that "a pluralistic cultural milieu will more likely infuse a developing talent with the capacity to conceive new combinations of concepts and techniques that will support historically significant innovations" (p.92).

Sometimes the diversity takes the form of actual physical encounters between people of different cultures, and other times it has been the ideas and more generally the products of one culture that influenced another culture. While Paul Gauguin actually went to Tahiti, Van Gogh never went to Japan, but he was deeply influenced by the work of Japanese painters whose work was beginning to be exhibited in Europe's major centers. Fascinating loops of influence are created. In the 1950s and 1960s, musicians in England and African nations such as Mali and Nigeria heard American blues, jazz, and rock, and were influenced by them. The British Invasion brought bands like The Beatles and The Rolling Stones to the United States, and they in turn influenced generations of American musicians. Musicologists and musicians such as Ry Cooder traveled to Mali to hear how African music has been at the roots of American blues, brought over with slaves, and performed with Malian musicians.

Jazz and Openness to Diversity

Jazz is considered to be one of America's greatest contributions to the arts. It originated at the beginning of the 20th century in New Orleans, a city with a rich diversity of cultural influences. In the case of jazz, these influences included complex African rhythmic and improvisational traditions, European instruments and harmony, substantial contributions by often conservatory trained Creoles (free Blacks who spoke Spanish and French), as well as the Black Church and Tin Pan Alley songwriters, many of whom were Jews of Eastern European descent.

Jazz emerged out of the interaction of musicians from many rich and diverse cultures and musical traditions working together in an environment that offered many opportunities to perform. It has continued to be an open, interactive musical tradition, continuing to draw on a plurality of other musical styles. Jazz has been an open system, where innovators and conservatives have been in continual dialog and as a result, it has developed many significant sub-categories. A number of musicians drew explicitly from Western classical music. For instance, Duke Ellington recorded Tchaikovsky's *Nutcracker Suite* and Grieg's *Peer Gynt*, Charlie Parker recorded the lush *Charlie Parker with Strings*, and Miles Davis's recording *Sketches of Spain* included the second movement of Spanish composer Joaquín Rodrigo's *Concierto de Aranjuez*. Latin Jazz continues to be an important branch, first brought to popular attention by the Juan Tizol composition *Caravan* for the Duke Ellington band, and then the popular work of Dizzy Gillespie and Stan Kenton. In the 60's the Bossa Nova sound exemplified by the classic and commercially successful recording by Stan Getz and Antonio Carlos Jobim, *Girl from Ipanema*, led to the incorporation of Brazilian rhythmic and harmonic sensibilities. The Third Stream movement involved the incorporation of elements from European classical music, most notably in a traditional small group setting, with the Modern Jazz Quartet being perhaps the most notable example. Leading figures such as Miles Davis, Herbie Hancock, Chick Corea, and groups such as Weather Report, Headhunters, and Return to Forever incorporated elements from rock and funk. Weather Report's Joe Zawinul led *The Zawinul Syndicate*, an innovative band that over the years has included musicians from several continents including vocalist Sabine Kabongo from Belgium and the Congo, drummer Paco Sery from the Ivory Coast, percussionist Aziz Sahmaoui from Morocco, percussionist vocalist Arto Tunçboyacıyan from Turkey, and guitarist Amit Chatterjee from India. Herbie Hancock's *The Imagine Project* album featured collaborations with musicians such as Ireland's The Chieftains, Indian sitar player Anoushka Shankar, Malian singer Oumou Sangaré, and others.

The challenge with these projects that bring together diverse musicians who often very different musical backgrounds is the integration in a cohesive whole where, once again, the whole is more than the sum of the parts, rather than less. While these two projects have been successful, is certainly not the case that every such effort at bringing musicians from different cultures has been equally successful. Research on group creativity is in its infancy compared to research on creative individuals, but the challenge of diversity with all its potential makes it an even more urgent task.

The changing styles that emerge from these interactions are reflected in the changing categories of the Recording Academy's Grammy awards, music's equivalent of the Oscars. In the 1960s and 1970s, there were obviously no categories for rap, since the genre had not yet been created. The categories are determined largely by the number of submissions in each one, and therefore reflect the popularity of different styles. Certain categories grow and others shrink or even disappear, and controversies have developed about the loss of certain categories, such as the temporary disappearance of Latin Jazz, and the criteria for categorizing music. It is hard to assess how to categorize the increasing number of recordings that span multiple categories, such as rap and metal, or works with American and African musicians that trace the African roots of the blues in Mali. Ever more capacious umbrella terms such as Roots Music have been used to encompass multiple genres of music. A term like "world music" essentially embraced a huge number of genres and artists from all over the world simply by setting them in opposition to popular music in the United States and to a lesser extent Europe. The term has come in for criticism because it reflects an attitude that marginalizes any non-Western music as "the rest."

Continuing musical cross-pollinations also point to areas of potential controversy when it comes to the relationship of creativity and diversity. The evolution of music through interactions and blending of styles and categories raises complex questions about authenticity and appropriation. There is a long history of musical appropriation where, for example, styles that originate, in the African American musical tradition are appropriated by white performers who benefit financially from them in way that the original artists never did. While the idea of musical or other cross-pollinations may be appealing and contribute to a sense of an emerging global culture, matters are never as simple as that. The American singer-songwriter Paul Simon worked with South-African musicians to record his extremely successful album *Graceland* (1986). At that time there was an artistic embargo on South Africa in protest against the *apartheid* regime. Simon's decision to record with the South African musicians of Ladysmith Black Mambazo was very controversial and illustrates a tension between creativity and ethical and political concerns. Besides being a musical success, Simon's recording did a lot to draw attention to South Africa's enormously creative musical tradition, and the shameful *apartheid* policies but opinions are still divided about his decision.

Musical performance and music appreciation can bring people together. Interactions and friendships between members of different groups, or cross-group friendships, can promote positive attitudes toward other groups and reduce prejudice. The effect extends to people who know others who have cross-group friendships (Davies et al., 2011). In the case of diverse groups coming together for purposes of musical interaction across cultures there is typically a mutual respect for musicianship, a feeling of friendship among musicians and a sense of belonging to the same "tribe" (musicians) regardless of ethnic or national background. The experience of working with people one respects leads to the possibility of friendship and a diminution in prejudice. Creative collaboration, in this case in a musical context, is therefore a model for the process of bringing together people from widely different backgrounds. Engaging in a creative activity with people from different groups can therefore serve as a way to bring people together, create positive attitudes, and the effect can spread to people who are not directly involved in the activity.

Culture and Creativities

Creativity is not conceptualized and experienced in the same way throughout the world. China and Japan offer particularly useful examples of perspectives that are different from the American view of creativity. With the increasing emergence of a planetary culture

it is becoming clear that there are diverse ways of understanding creativity, and a range of creative practices. If the current definition of creativity is reduced to “original” and “authentic” as some Western scholars have recently suggested, these terms still appear to resonate in different ways in China and the United States, for instance (Niu and Sternberg, 2006). Creativity offers a fascinating lens to understand differences between cultures, and the differences can at times be dramatic. Chinese cosmology does not focus on cosmogony, or the origin of the Universe, but on the interconnectedness of all of existence, and views the cosmos as a process of continuous creativity (Tu, 2007) (See Regional Creativity: Asia).

The related concept of “originality” illustrates some of the differences. In the West, the value of the original, such as an original Picasso, simply cannot be compared to a copy no matter how good. The value of the original also depends on its condition. The better the condition, the cleaner the work, the higher the value. Chinese masterpieces, on the other hand, are regularly overwritten by scholars and collectors, who add inscriptions and seals. The work is always transforming, and the more famous it is the more it transforms. It would be hard for a Westerner to imagine the Mona Lisa with hundreds of years’ worth of inscriptions and seals, or to conceive of it as still changing and transforming.

The Ise Grand Shrine is a Shinto temple in the city of Ise, Mie Prefecture in Japan. It dates to 4 BCE and is dedicated to the Sun Goddess Amaterasu. For the Western visitor, a particular detail makes the shrine unusual: it is torn down and rebuilt every 20 years. If the Colosseum in Rome were to be torn down and rebuilt (in its original splendor) every twenty years, it would somehow not be the Colosseum for the Western visitor. It would be more like something one might find in Disneyland or Las Vegas, certainly not a national treasure as it is in Italy.

In China the term shanzhai is a neologism that describes a “fake.” Shanzhai cell phones may be sold under the brand Nokir or Samsing (rather than Nokia or Samsung), sports equipment may be sold with the name Adidos. They are considered to be just as good—and at times even better—than the “originals,” and may even contain notable improvements. There are shanzhai versions of Harry Potter stories (*Harry Potter and the Porcelain Doll*), with Chinese characters featuring the evil Yandomort. Shanzhai iPhones are sold as iPncne, which looks like faded lettering. These items are said not to be inferior to the “original,” and in fact are celebrated for their play on the “originals.” In the West, the Harry Potter story would be considered fan fiction, but Chinese culture does not have the same worship for the original, and may be interpreted as simple plagiarism, deception, and copyright infringement (Han, 2017). The moral and interpersonal dimensions are of much great importance in the Eastern view of creativity. The view of creativity is much broader and takes into account social and cultural contexts, focusing on appropriateness in ways that reflect a culture that not individualistic (Niu and Sternberg, 2006).

Attitudes Towards Diversity

While certain individuals are open and indeed fascinated by diversity, others tend to fear and reject it. One of the terms that is most closely associated with diversity is prejudice. Extensive research on the psychology of prejudice, racism, and authoritarianism has presented a rich and disturbing picture. Writing in the classic *The Authoritarian Personality*, Elke Frenkel-Brunswik (Adorno et al., 1950) compared findings on individuals who were prejudiced with those who were not. She stated that it is perhaps mainly the readiness to include, accept, and even love differences and diversities, as contrasted with the need to set off clear demarcation lines and to ascertain superiorities and inferiorities, which remains as the most basic distinguishing criterion of the two opposite patterns (pp.485–486).

In other words, when confronted with differences and diversities Authoritarian individuals feel the need to erect walls, metaphorical as well as literal, and establish who is on top, as opposed to successfully integrating differences, as we saw in the example of jazz musicians.

Frenkel-Brunswik articulated a central difference between prejudiced and non-prejudiced, but also between authoritarian and creative persons. It reflects two different ways of being in the world, and certainly two radically different relationships to diversity. Based on extensive research from political and social psychology as well as creativity research, there is a profile of authoritarian individuals who are closed-minded, intolerant of ambiguity, who think in rigid categories and dichotomies, and approach diversity and complex situation with quite relentless and unrealistic simplicity, focusing above all on establishing who is strong and who is weak, who is superior and who is inferior (Montuori, 2019).

Followers of authoritarian leaders crave cognitive closure, meaning that they want a clear and certain answer—any answer—when faced with complex phenomena. When faced with phenomena that are diverse, different, and ambiguous, they want clarity and certainty. They stick with a fixed view and are prone to overgeneralize and stereotype. The world is seen dualistically, in terms of black and white. Solutions are arrived at as soon as possible, in order to avoid ambiguous and unstructured situations that can lead to anxiety, discomfort, and fear. Diversity, or a plurality of perspectives, is viewed as a problem to be resolved: there is only one right way, one source of authority, and any other perspectives are not only wrong, but in all likelihood bad and threatening.

Milton Rokeach’s concept of dogmatism, which he felt represented a generalized authoritarianism better than the original 1950s study, showed that shared belief is a more important factor in social discrimination than belonging to a shared ethnic or racial group. Dogmatic persons cannot tolerate the coexistence of different belief systems, resist changing beliefs even when faced with information that invalidates them, and appeal to authority to support beliefs (Rokeach, 1954). The increasing complexity of diverse perspective stresses the ability to integrate phenomena, and one way to deal with that is to inhibit the emergence of the higher level of complexity, by not allowing them into consciousness. These are characteristics of prejudiced, authoritarian individuals. They are low on integrative complexity, less curious, and seek to eliminate diversity.

In his classic on the psychology of prejudice Gordon Allport argued that generalizations are a natural way to simplify a complex world. The key difference between the normal use of generalizations and prejudice is that prejudiced persons do not change their minds when confronted with information that disproves their beliefs. The person who is not prejudiced remains open to the possibility of change, whereas the prejudiced person does not.

At the other end of the psychological spectrum one finds individuals who are high on integrative complexity, open to experience, tolerant of ambiguity, have independence of judgment and complexity of outlook. As Frenkel-Brunswik put it, they include, accept, and even love differences and diversities. These are creative individuals, who also tend to be more cosmopolitan and less ethnocentric, curious about difference and diversity, more interested in other cultures and a multiplicity of perspectives. They view diversity and multiple perspectives as a source of creativity, rather than as a threat, and are open to changing their minds.

Particularly relevant for this discussion of diversity is Integrative Complexity, which addresses the complexity of information processing and decision making (Tuckman, 1966). Integrative complexity reflects the degree of differentiation and integration of multiple perspectives. Individuals who are low on integrative complexity see the world in black and white terms, avoid ambiguity and multiple possibilities. They stick with a fixed view, overgeneralize, and stereotype. Stereotypes simplify the complexity of the world. They place large numbers of people in a category and avoid the ambiguity of having to navigate the unknown and learning about a specific person, for example. Learning about a person may bring the knowledge that they do not conform to a pre-established, stereotyped view of the category of people they belong to, and this is something to be avoided because it might challenge deep-seated beliefs and ways of ordering and evaluating the world. Individuals with high integrative complexity perceive a diverse world with many alternatives. They view the world in a flexible and complex way and can respond in appropriate and novel ways. There is a strong positive relationship between high integrative complexity and creativity.

A further diversity-related contrast between authoritarian and creative individuals pertains to gender. Authoritarians often have very rigidly polarized conceptions of masculine and feminine roles. They can be described as oppositional identities. A man is a man to the extent that he does not engage in behaviors or express feelings that are associated with women, and vice versa. Authoritarian individuals have a strong focus on boundaries and reject ambiguity—as Frenkel-Brunswik put it, the need to set off clear demarcation lines and to ascertain superiorities and inferiorities—and as a result, anything that creates ambiguity in gender role and sexual identity is rejected outright.

In creative persons we find the opposite is true: The personality characteristics historically associated with men and women are not nearly as strong in creative people. Creative women, for instance, have been found to have fewer traditionally feminine interests, and more generally Barron (1972) wrote that “sex-specific interests and traits that are descriptive of men and women in general seem to break down when we examine creative people” (p.33). The authors of the classic authoritarian personality research found that whether one accepts tendencies of the opposite sex in oneself or not was an issue of great importance because these attitudes are generalized and projected into the social sphere. This is seen in the way that in authoritarian or religious fundamentalist regimes and communities gender roles are immediately differentiated (in terms of superiority/inferiority) very clearly, whether in Nazi Germany or Iran after the revolution. There is a rigidity in roles that reflects the overall rigidity found in authoritarian individuals, compared to the greater openness and flexibility of creative individuals.

Travel and Culture: Diversifying the Mind

Individuals who are exposed to a wide variety of perspectives are more likely to realize the arbitrary nature of any particular cultural norms and values, whether intellectual or aesthetic, and thereby impose fewer restrictions on the scope of their creative imagination (Simonton, 1997, p.92, p.92)

It is said that travel broadens the mind, and multicultural experiences can in fact enhance creativity (Leung et al., 2008). But this doesn't mean that every brief holiday on a foreign beach necessarily increases creativity. A deep immersion in a different culture combined with reflection on the experience can make the difference. Bicultural individuals who have experienced and internalized two (or more) cultures, have greater ideational fluency and tend to be more creative, and there is a proportionally large number of first and second-generation immigrants among eminent artists, inventors, and scientists. Exposure to another culture is a way of diversifying. Exposure to often radically different cultural norms and values can lead to an understanding of the extent to which these norms and values, whether political, cultural, intellectual, or aesthetic, are not absolute, but rather human creations. As a result of this exposure the world is seen as less fixed, more fluid and open. These multicultural experiences show that what was thought to be fixed and given, or “just the way things are,” is not always the case. On a very basic level this offers more choices, greater differentiation, and the ability to see the world from more than one perspective. This in turn allows for more and different connections between disparate elements, and fosters creativity.

Individuals who have *essentialist* views of racial groups believe that there are fixed underlying racial essences. They see all individuals that they identify as belonging to a specific race as having the same fundamental characteristics. Others believe racial categories are socially constructed, in which case the differences ascribed to races are the result of historical events that emerged over time and were influenced by cultural and political perspectives, as well as the science of the day. The belief in racial essences leads to more use of stereotypes. Inferences are made about a person on the basis of one distinctive trait such as skin color or gender. Essentialism induces closed-mindedness and reduces domain-general creativity (Tadmor et al., 2013).

Closed-mindedness involves the desire for certain knowledge, as soon as possible, and to maintain it as long as possible (Kruglanski, 2013). Closed-mindedness is clearly hostile to diversity and creativity, because creativity requires what the poet John Keats called negative capability. This involves being able to stay with intellectual confusion and uncertainty and not wanting certainty as soon as possible. Wanting to maintain one's certainty as long as possible also points to remaining closed to the possibility of revising one's knowledge in the face of contrasting information.

One illustrative and dramatic event in which fixed views about norms, values, and everyday habitual practices can be loosened is culture shock. Culture shock is a phenomenon widely considered to be an unpleasant side-effect of sojourns in other cultures. Whether traveling for business or pleasure culture shock was certain to ruin the trip. Nevertheless it has been argued that the experience can shed some light on what can happen in cross-cultural experiences, and that culture shock can lead to a better understanding of one's identity, to cognitive and personal growth, and that creativity plays a role in the process (Montuori and Fahim, 2004). Culture shock involves the experience of a gradual accumulation of events that shake up what is considered normal. As a result, there is a loss in self-efficacy with a breakdown in habitual behaviors and ways of making sense of the world. The term culture shock can be misleading because it gives the impression that it may involve one major shocking event, when in fact it is the gradual accumulation of a series of small events that makes people feel they have lost their grip on life. It is when people are suddenly confronted with an inability to deal with the things they take completely for granted in their own culture, and the number of these breakdowns steadily mounts, then culture shock sets in.

Culture shock is an extreme example of a process that leads to an awareness that very different realities exist to the ones people take for granted and are accustomed to. Things that remain unquestioned in one's own culture, activities in which it is possible to engage in habitual and unreflective behavior, turn out to be quite different in other cultures. Breakdowns occur in our habitual patterns of thinking and doing, and these breakdowns offer people an opportunity to learn about themselves and their own culture, as well as the new culture they are visiting.

This process highlights how cultures are in fact largely human creations. One of the most important insights that can come about as a result of immersion in other cultures is a relativizing of one's own culture and one's own experience. Experiencing diversity that challenges expectations encourages greater tolerance, creativity, and benefits intergroup relations. Multicultural experiences, and more dramatically, culture shock, are intense diversifying experiences, unusual and unexpected the events that violate our cognitive schemas and can promote cognitive flexibility.

Creative individuals exhibit more openness for experience, and so actively seek out other perspectives. Individuals who are lower on integrative complexity reject the multiplicity of perspectives by placing them in a hierarchy, whereby perspectives other than theirs are viewed as inferior. Multicultural experience reduces the need for cognitive closure and can "unfreeze" bias toward out-groups. This is attenuated by environments that strongly evoke the need for cognitive closure with an existential threat or when for some reason individuals are highly motivated to have definite knowledge. A way to heighten fear of difference and diversity and keep out-group bias frozen, therefore, is for authoritarian leaders to use propaganda to promote the existence of an existential threat coupled with a great deal of social insecurity (See Travel).

Diversity and Inclusion in Creativity Research

Creativity research has historically not drawn on a very diverse sample of the population, and for the first 40 years after J.P. Guilford's presidential address that kick-started research in the psychology of creativity, creativity researchers themselves were also almost entirely white, mostly American men, who researched other white men who had been identified as creative. It is also the case that most of the research in the psychology of creativity was conducted in the United States and focused on finding and studying exceptional individuals in specific elite domains in the arts and sciences.

The creators and thinkers featured in two classic edited books with leading creative figures as well as creativity researchers, Brewster Ghiselin's *The Creative Process*, and *The Creativity Question* by Rothenberg and Hausman, are almost entirely male and completely white. Historically in Europe and the United States individuals considered eminent creatives such as Nobel-prize winners, and great composers, artists, and novelists, were almost entirely men. Women have received far less attention than men in creativity research, and there is relatively little research on creative people of color. The mythology of genius, which dates back to Romanticism and has remained quite pervasive into the 21st century, included the notion that genius would overcome all obstacles (Montuori and Purser, 1995). This implied that social factors are not relevant and do not get in the way of the real genius, who will be recognized no matter what the circumstances. Consequently, if people of color and women did not become eminent creatives it must have been because they were not creatively brilliant enough, not because they were not given the opportunity to participate in the very domains where one could be recognized as a genius. Any explanation for their absence could be sought "inside" them, in their personality, cognitive style, motivation, or perhaps the nature of the "female brain," or the "race."

Anne Roe was the one of the first women to engage in systematic creativity research, at a time when there were few women researchers. Her research on eminent scientists was first published in 1953. It is telling that when she received tenure at Harvard in 1963, she was only the ninth woman to become a tenured faculty member, and the first woman to receive tenure in the Harvard School of Education. This should put the paucity of women in Ghiselin's book, which was published in 1954, somewhat in perspective, and also point to the slow but significant changes.

Barron's research on student artists at the San Francisco Art Institute already pointed to some interesting differences in the ways men and women viewed themselves as artists (Barron, 1972). The men stated that art was their whole life and that they could not

conceive of being anything other than artists. The women had a broader, more diverse view of themselves, putting friendship and family as equally important in their lives. The stereotypical image of the artist would suggest that compared to the women who appeared less fully committed, the men with their explicit passion, focus, and commitment would be the better artists. But when the work was presented to judges anonymously the women's work was judged to be equal in quality to the work of the men. This clearly reflects how some of the cultural assumptions and myths about creativity and the creative process are products of a particular time and place. They may not have directly affected the creativity of the women at the San Francisco Art Institute, but there is no doubt that cultural assumptions about the who, how, where and when of creativity have been a serious impediment for women.

Ravenna Helson argued that in order to understand the creativity of women a different approach to research was needed, one that focused more on the social world, not least because society historically actively prevented women from participating in domains such as science and the arts where one could achieve eminence. Her proposal, more recently embraced by researchers with an interest in social creativity and the socio-cultural approach, should also be applied to the development of a better understanding of traditionally under-represented groups in creativity research.

The focus of much creativity research has historically been on individual creativity (novelists, composers, individual scientists, the "lone genius") and not on the performing arts. This has meant that in the United States until recently there has been little research on creative groups and more broadly on creative interactions. The contribution of African-Americans to America's pre-eminent native art form, jazz, has gone largely unaddressed in the research. Eminent African-American creators have been profiled and studied but not in what is traditionally viewed as creativity research. Creativity research has found that there are few differences in creativity between African Americans and European Americans, and they have been found to tend to favor African Americans (Kaufman, 2006). Interestingly, African Americans were less likely to fall prone to gender stereotypes in creativity. In addition, African Americans and Native Americans tend to rate themselves as more creative than other ethnicities.

The historic absence of women and people of color in lists of eminent creatives is clearly attributable to social conditions that simply did not allow them access to the domains where it was possible to become an eminent creative. No representation without participation. As more women and people of color are participating in the rarefied domains in science, business, and the arts, where one can get recognition for outstanding contributions, they are now appearing in lists of eminent creatives. Nevertheless, there are still domains where women and people of color are conspicuous by their absence, and where they are still excluded in subtle and not-so-subtle ways. Minority students continue to be under-represented in programs for gifted students. Identifying these gifted students becomes a vital task, but the way they are identified is through standardized tests which are known to be problematic, since there are significant differences in aptitude and ability between ethnic groups and critics have also stressed how cultural differences make the tests less applicable. In order to do justice to the complexity of diversity, creativity research will also have to question and diversify its own fundamental assumptions and research methods.

Conclusion

The relationship between creativity and diversity is a fascinating one and a timely subject for research. There are individuals who are not open to diversity and feel threatened by it, as history, current events, and extensive research on all forms of prejudice shows. Research suggests that individuals who are more open to embracing diversity are also more creative, and that experiences of cultural diversity can promote creativity.

The relationship between creativity and diversity suggests a wealth of possible research opportunities. Topics include the differences between creative and prejudiced individuals, what makes individuals more open to diversity, how to educate for openness to diversity, the study of populations who have been under-represented in creativity research, what makes diverse groups, organizations, cities, and cultures creative, how different cultures develop different understandings of creativity, and more. This research will need to address a lot of interconnected phenomena and levels of analysis. As it will cross a wide range of disciplines, it will by necessity have to be inter- or transdisciplinary, and should encourage creativity researchers to collaborate with colleagues in disciplines where some of the above questions have been addressed already, albeit usually without drawing on the extensive research on the psychology of creativity. Not surprisingly, diversifying creativity research raises a lot of fundamental questions, as any cross-cultural experience raises questions about one's own culture. The definition of concepts like creativity, originality, innovation, and social creativity, will be contrasted with other views, and it is to be hoped that creativity researchers, an increasingly diverse group, will engage these possibilities with alacrity.

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Domains of Creativity[☆]

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Introduction

Single-factor theories of creativity, like single-factor theories of intelligence, are very appealing because they allow one to paint the full picture of creativity—or at least a large part of it—with a single brushstroke. If creativity were a general trait or a single set of cognitive skills that influenced creative performance of all kinds, it would be much easier to understand, train, and test creativity.

Although single-factor theories of creativity have been popular for many years and have long dominated creativity assessment, there is growing evidence that they may not explain creative performance across a wide variety of content domains as well as more narrowly defined, domain-specific theories and assessment techniques. In fact, there is considerable evidence suggesting that the skills underlying creative performance are not even so general as to span the many tasks that make up such common content areas as the verbal, mathematical, or artistic domains. This task specific (or microdomain specific) view of creativity argues that the skills that lead to creativity on one task in a broadly defined domain of knowledge, such as writing, are not the same (and show little overlap with) the skills that lead to creativity in another task within the same writing domain. Thus, for example, poetry-writing and story-writing creativity may not rely on the same set of cognitive skills, and creativity in writing plays might call on yet a third distinct set of creativity-relevant writing skills.

Such a fragmented approach to creativity, in which every domain (or even every narrowly defined task within a domain) relies on its own unique underlying set of traits or skills, is naturally less satisfying than a grand, all-encompassing theory of creativity. The most widely held general view of creativity, which posits divergent thinking to be a general, domain-transcending skill applicable in all areas of creative endeavor, has been popular in creativity theory, training, and testing for many years, and despite doubts raised regarding the possible validity of *any* general theory of creativity by new research suggesting that creativity must be domain specific, divergent thinking theory continues to be used widely both in education and psychology.

After outlining the evidence for domains of creativity and current understandings of domain specificity and domain generality, this article will conclude by examining the implications of domain specificity of creativity for creativity theory, testing, and training. It will also consider theories that bridge generality and specificity and discuss how a newly emerging metatheory of creativity that is rooted in a modified divergent thinking theory and that incorporates a domain specific view of creative-thinking skills can replace earlier general theories as a unifying idea in creativity theory, training, and testing.

Domains and Domain Specificity

The concept of a domain as a set of representations or understandings underlying comprehension of a specific area of knowledge and performance of the tasks associated with that domain is, at the conceptual level, a fairly clear one. Applying this definition in a way that demarcates domain boundaries can be a much more contentious exercise, however.

In 1983 Howard Gardner published *Frames of Mind: The Theory of Multiple Intelligences*, and the domains (or, as Gardner termed them, “intelligences”) that he described have become familiar to many readers and are especially influential in the field of education. Gardner has distinguished the following intelligences:

- linguistic intelligence (abilities having to do with understanding and using the sounds, rhythms, and meanings of words and the functions of language)
- musical intelligence (abilities having to do with understanding and employing rhythm, pitch, timbre, and musical expressiveness)

[☆] *Change History*: December 2018. John Baer updated the text throughout the article.

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- logical-mathematical intelligence (abilities having to do with finding logical and numerical patterns and producing chains of reasoning)
- spatial intelligence (abilities having to do with understanding the visual-spatial world and transformations within that world)
- bodily-kinesthetic intelligence (abilities having to do with control of one's body movements)
- interpersonal intelligence (abilities having to do with understanding and responding appropriately to the feelings, moods, and motivations of others)
- intra-personal intelligence (abilities having to do with understanding one's own feelings, moods, and motivations, with assessing accurately one's own strengths and weaknesses, and with drawing upon such knowledge to guide one's behavior)
- naturalist intelligence (abilities having to do with recognizing, categorizing, and drawing inferences about features of the environment; this intelligence was added later and was not part of the original list of seven intelligences)

Gardner's classification is based on such evidence as (a) the effects of brain trauma, such as strokes, that influence functioning in one domain but not others; (b) the existence of prodigies and autistic savants who show extreme abilities in one domain but not others; (c) psychometric evidence that suggests consistency among the skills that lie within a given domain and independence between the skills that fall in different domains; and (d) the existence of a set of core information-processing operations that can deal with specific kinds of input.

Gardner's eight intelligences are not the only way that domains have been conceptualized, but they will suffice as an illustration of the idea of broadly defined cognitive domains. The term domain is often also used to refer to general fields of knowledge or ways of knowing without specifying clear-cut boundaries between domains, and the breadth of what may be properly called a domain is in most instances not precisely defined. For example, a child's understanding of gravity may be viewed as a different domain of knowledge than her understanding of object permanence, number, animacy, and so on. It is also possible to lump many such understanding together as a single larger and more inclusive domain (in which case, for example, a child's understanding of gravity and her understanding of object permanence, number, animacy, etc., might be thought of as all falling within the domain of early mathematical and scientific concepts). Overall, as the idea that cognitive development is domain specific has increased in popularity among psychologists, the number of such domains has also tended to increase, and the breadth of the hypothesized domains has tended to shrink.

Some writers use the term microdomain to refer to subsets of skills that seem to go together and yet have somewhat separate developmental histories. The use of pronouns, for example, can be considered a microdomain within the larger linguistic domain, and counting skills can be thought of as a microdomain within the larger mathematical domain. There are not clear guidelines for demarcating domains and microdomains, and usages often overlap.

An important area of disagreement among those who argue for the significance of distinct domains of knowledge is the possibility of interaction among the skills and knowledge that make up the various cognitive domains. Some theorists argue for strict modularity; under such an interpretation, each information-processing module is encapsulated and cannot make use of representations from other modules. One oft-cited example of such an encapsulated module is the perceptual system, which is at least relatively immune from input from other modules (and thus one's beliefs or preferences cannot interfere, or can interfere at most only slightly, with what one sees or hears—and the fact that one does not want or expect to see an elephant in one's living room will in no way interfere with actually seeing or hearing an elephant if one should appear there!). Strict modularity is an extreme version of domain specificity, but modularity and information encapsulation are not essential features of theories of domain specificity.

Evidence for Domains of Creativity

Any evidence that there are different cognitive domains, even when that evidence is collected without consideration of levels of creativity, is indirect evidence that creativity is domain specific. This is true for the simple reason that creative performance must occur in *some* content domain; and if the basic cognitive skills underlying performance in that domain are domain specific, this will necessarily have an impact on creative performance in that domain as well as the performance of more ordinary tasks in the domain (tasks unrelated to creativity). And to some degree there is no dispute about domain specificity because everyone acknowledges at least some differences in the skills and knowledge one needs to perform or work or produce artifacts in different domains (e.g., no one questions that there are skills required in watercolor painting that are not needed in playing an oboe, and vice versa).

Questions about the domain specificity or domain generality of intelligence—which includes, for example, disagreements such as those raised by Gardner about the degree to which generic intellectual competencies exist and can be tested, as is assumed in standard IQ testing—are beyond the scope of this article, although they are clearly relevant because creativity requires competent performance as well as creative performance in a given domain. (They also provide a model for how to test the domain specificity/generality question in creativity, as discussed below.) The evidence for domain specificity of creativity goes beyond the assertion that different content domains rely on different basic skills for performance of all kinds, however. Even if there is a significant degree of general intellectual ability (or *g*, which is what IQ tests purport to measure) that influences performance across many domains, creativity may still be largely domain specific as long as *g* accounts for only a fraction of the observed differences in performance across domains. Domain specificity in creativity isn't an argument against (or for) general intellectual skills per se. What domain specificity theorists claim is that the skills, traits, and understandings that underlie *creative* performance—which are conceptualized as a set of skills, traits, and understandings that go beyond those skills needed for successful (but not necessarily creative) performance—vary from domain to domain. Under domain specificity, general intelligence might still influence performance across domains, but

creativity-specific skills or traits (such as divergent or associative thinking, resistance to premature closure, openness to experience, or intrinsic motivation) are not domain general skills of the kind that general intelligence (*g*) is theorized to be.

Arguments for the domain specificity of creativity are based primarily on research into the creativity of actual creative products, such as works of art, and not on the testing of specific intellectual abilities associated with various content domains. This evidence suggests that levels of creative performance on tasks in one domain are essentially unrelated to levels of creative performance on tasks in other domains, especially once the effects of *g* (as measured by IQ or similar general aptitude tests) have been statistically removed. This research has even shown that creativity in performing one kind of task within a broad cognitive domain may be unrelated to creativity in performing other tasks within the same domain.

A widely used technique in creativity research is to ask subjects to create something and then to have groups of experts in that field independently evaluate the creativity of those products. This method is called the Consensual Assessment Technique. It was developed and validated by Teresa Amabile (1996) in the early 1980s and has been used widely in creativity research since then. It is based on the idea that no matter what creativity may turn out to be and no matter what theory may someday best explain it, judgments of the creativity of work, products, or performances in a given field are most appropriately made by recognized experts in that field. Thus the creativity of poems is best judged by poets and poetry critics, and the creativity of cosmological theories is best judged by cosmologists. Although at the cutting edge of any field, places where paradigm-shifting work is likely to be the focus, there may be many disagreements about the creativity of a particular work or idea, assessments of more garden variety or everyday creativity—the kind of creativity that occurs in most psychological studies of creativity—tend to produce fairly uniform judgments among appropriate experts. Thus by asking a group of artists and art critics to independently evaluate the creativity of a group of collages, or a group of fiction writers and critics to independently evaluate the creativity of a group of stories, a researcher can obtain a reliable and valid measurement of the creativity of a group of creative products.

Many studies using subjects of different ages ranging from kindergarten to adults have shown that when subjects are asked to produce more than one creative product—such as collages, poems, stories, and mathematical puzzles—the creativity ratings of the products of each individual vary significantly. In fact, there is often little or no relationship between the creativity ratings a subject's various works of *different* types receive, despite the fact that the level of one's creative performance on a given task is highly predictive of performance on the *same* task, even when the second work is produced as much as a year after the first. For example, one especially large study examined the creative performance of participants in seven tasks, three art tasks and four creative writing tasks, allowing for multiple tests of domain specificity (including ones using combined art-mean and story-mean scores). The 16 within domain correlations were consistently large and statistically significant, as both domain generality and domain specificity theories would predict. Not one of 20 the cross-domain correlations reached the 0.05 level of statistical significance, however (Conti et al., 1996).

This approach to testing the domain generality/domain specificity question—looking for intercorrelations of performance scores across domains—is exactly the method used by psychologists to demonstrate the presence of general intellectual skills—*g*—when the Board of Scientific Affairs of the American Psychological Association (APA) established a Task Force to produce “an authoritative report” (Neisser et al., 1996, p. 77) on what is actually known about intelligence. The Task Force concluded that “subtests measuring different abilities tend to be positively correlated: people who score high on one such subtest are likely to be above average on others as well” and that psychometric evidence suggested “a hierarchy of factors with *g* at the apex” (p. 78). But when the very same approach has been used to look for domain generality of creativity, it has come up empty-handed. Unlike the results when testing for domain-general intelligence, the results in the area of creativity have consistently supported domain specificity.

It should be noted that this lack of relationship among creativity ratings on different products is not only true across broadly defined domains—such as the linguistic and artistic domains—but also, in at least some cases, within domains. A prime example of such within-domain task specificity is the lack of correlation between poetry- and story-writing creativity that has been observed in several studies.

Approaching the question of domain specificity of creativity from a creativity training perspective, it has also been shown that training in divergent thinking (which is the most common kind of creativity training exercise) can also be targeted to specific domains, or even to specific tasks within domains. For example, divergent thinking training using only poetry-relevant exercises—such as brainstorming words with similar beginning sounds (alliteration) or words that can stand for or represent a given thing or idea (metaphor)—tends to increase poetry-writing creativity but fails to increase story-writing creativity.

An important source of evidence *against* domain specificity of creativity—evidence favoring domain generality of creativity—comes from studies using self-report scales of creativity. When individuals are asked to rate their creativity across various domains, the levels of creative achievement they report in the various domains tend to be moderately correlated. Critics of this research point out (a) the questionable validity of self-report scales and (b) the response-set bias that may lead individuals to systematically under- or over-estimate their own creative activities in all or most domains.

Most tests of creativity assume domain generality — they are billed as tests of creativity, not tests of creativity *in Domain X* — but the most widely used such measure has, perhaps inadvertently, provided fairly strong evidence of domain specificity. The Torrance Tests of Creative Thinking, which purport to measure domain general creativity, were for many years the most widely used tests of creativity; in fact, in a 1984 study, Torrance and Presbury reported that the Torrance Tests accounted for three-quarters of all creativity research involving students and 40% of the smaller subset of all creativity research involving adults as subjects. There are two forms of the Torrance Tests — figural and verbal — and Torrance himself found these two forms of his test measured essentially different skills. “Responses to the verbal and figural forms of the TTCT are not only expressed in two different modalities... but they are also measures of different cognitive abilities. In fact, Torrance found very little correlation ($r = 0.06$) between performance on the verbal and figural tests” (Cramond et al., 2005, pp. 283–284). Kim (2017) has reported somewhat higher correlations between the two forms of the test in recent studies. The highest r of these studies was just 0.39, however, and others were

significantly lower. The corresponding estimates of shared variance between the figural and verbal forms of the Torrance Test in the four studies Kim cited thus ranged from less than one percent (which is also what Torrance found) to a high of 15% (this was the 0.39 study; $.39^2 = 0.15$). This suggests at most small amounts of overlap (domain generality) and large amounts of disjunction (domain specificity).

In 1998 the *Creativity Research Journal* published a Point-Counterpoint pair of articles debating the issue (Baer, 1998; Plucker, 1998) in which even the psychologist arguing for domain generality acknowledged that “Recent observers of the theoretical and empirical creativity literature could reasonably assume that the debate is settled in favor of content specificity” (Plucker, 1998, p. 179). Creativity theorists and researchers are far from unanimous about how best to interpret the available evidence regarding domain specificity of creativity, however, and although the trend in recent years has favored a much more domain specific approach, this could change depending on the results of future research.

It is interesting to note that the efforts to produce creativity in the area of artificial intelligence has also followed a very domain specific path. The earliest visions of artificial intelligence imagined robots that could speak and act much like humans — one leader, Herbert Simon, claimed in 1965 that “machines will be capable, within twenty years, of doing any work a man can do” (Crevier, 1993, p. 109). In fact, 20 years after making that prediction AI had largely shifted toward an expert systems approach, developing programs that answer questions and solve problems about very limited and specific domains of knowledge. Recent computer program success have included software with considerable levels of creativity, but almost always in very specific domains such as playing games like chess and Go, medical diagnosis, and musical composition (e.g., <http://artsites.ucsc.edu/faculty/cope/experiments.htm>). Domain general computer software has yielded little that observers might deem creative, but narrowly domain specific computer programs have produced creative accomplishments in many fields. This is not evidence that human creativity is necessarily domain specific, of course, but combined with research showing human creative performance tends to be strongly domain specific it does suggest that there may be something domain specific about the very nature of creativity, whatever its source.

Common Misunderstandings About Domain Specificity: The Puzzle of Polymaths

There have always been a few people of exceptional talent who are highly creative in multiple domains. Some observers focus on the rarity of such polymaths and take this as evidence in favor of domain specificity; others home in on the existence of polymaths, however rare they may be, and take it as evidence for domain generality. Either way, such arguments are misleading. Domain specificity does *not* predict there will be no polymaths; in fact, it predicts that some such multi-talented people should exist. And domain generality theorists can explain their rarity just as easily.

What domain specificity claims is that creativity in one domain does not predict creativity in other domains. It thus claims that correlations between creativity in different domains should, on average, be zero. This means that one should expect some people will have high levels of creativity in many areas and some should demonstrate very low levels of creativity in many areas, not that everyone should be creative in the same number of domains. Some creative painters might also be creative poets, while other creative painters might exhibit no creativity as painters whatsoever. (By way of analogy, think of any two unrelated traits, such as having green eyes and being tall. The fact that a few people with green eyes are also tall does not show these traits are related. When two factors are unconnected, they should be expected to appear together in some, but not most, cases. This is what randomness predicts.) If domain specific creative abilities are randomly distributed, one would *expect* a few people to be creative in many domains, some people to be creative in several domains, and some others to be creative in few domains or none, based on a normal distribution of unrelated abilities. The existence of a few polymaths does not disprove domain specificity. It is *exactly* what domain specificity predicts.

For very different reasons, the scarcity of polymaths can be explained by domain generality theorists, at least creativity at the highest, genius level. If creativity is domain general and a person has enough of it to be highly creative in any domain, then it might seem that one should be creative across the board. Most genius-level creators are *not* immensely creative outside the one domain in which they show excellence, however. This is probably best explained but what creativity researchers call the “ten-year rule,” which argues that it takes many years of preparation in a field before one can do ground-breaking work in that domain. If it takes ten years of hard work in a field before one can produce works of genius, it is hardly surprising that few people manage to reach the highest levels of creativity in a variety of fields. There simply isn’t time.

So the presence of creative polymaths tells us nothing about domain specificity, and their rarity tells us nothing about domain generality. In this case, both theories predict well the world as we find it.

Mixed and Hierarchical Models

Creativity theorists needn’t choose simply between domain generality and domain specificity. There are theories of creativity that incorporate aspects of both positions.

At the most basic level, one can simply posit the existence of both domain general and domain specific skills and traits. Amabile’s (1996) componential model, which argues for three factors—creativity general skills and knowledge, domain specific skills and knowledge, and task motivation—does just that.

Kaufman and Baer's (2005) (Baer and Kaufman, 2005) APT Model is a hierarchical theory of creativity that includes both domain general and domain specific elements. The central idea of a hierarchical model is that there are varying degrees of domain specificity and generality ranging from the most general, such as general intelligence (g), to the most specific (e.g., micro-domains or task specificity) There are four levels in the APT hierarchy:

- *Initial Requirements* are completely domain-general factors that influence creative performance to some degree across all domains (e.g., intelligence)
- *General Thematic Areas* are broadly defined fields or areas that include many related domains, such as Artistic/Verbal, Artistic/Visual, and Math/Science.
- *Domains* lie within larger General Thematic Areas and refer to more limited ranges of creative activities. For example, in the General Thematic Area of Artistic/Verbal one would find subdomains such as narrative fiction, drama, and poetry.
- *Micro-domains* refer to more specific tasks within domains. For example, within the domain of poetry one might find haiku, epic poetry, and sonnets.

A hierarchical model such as the APT provides a bridge connecting domain generality and domain specificity and argues that aspects of both theories should be not only acknowledged but incorporated fully into a complete theory of creativity.

Conclusions and Implications

If creativity is domain specific, it means that a single theory of creativity—such as the theory that divergent thinking is a basic component of all creative thinking—cannot account for the diversity of creativity across domains. Creativity theories must either become domain specific themselves or find some general approach to dealing with these domain-based differences. Similarly, domain specificity of creativity means that creativity testing as currently practiced is necessarily inadequate and of limited validity. And finally, creativity training programs cannot be assumed to increase creativity across all domains simply because they successfully promote creativity in one domain.

Baer (2010) has proposed a divergent thinking metatheory of creativity that, although encompassing all domains of creativity in a single conceptual scheme, nonetheless takes into account the domain specificity of creativity. According to this metatheory, divergent thinking is an important creative thinking skill, but the cognitive mechanisms underlying divergent thinking are different in each domain (or possibly even for each task within a given domain). Thus there are many *different* divergent thinking skills rather than a single divergent thinking skill. So, for example, divergent thinking skill in poetry would be associated with creativity in writing poetry, but not in creating collages, which would require an entirely different set of divergent thinking skills. Consider, by comparison, the thinking skill of “analysis.” Analyzing a sonnet, applied behavioral analysis, factor analysis, and analyzing tree rings might all require analysis, but in each case what we are calling “analysis” is entirely different. Divergent thinking as a general class of thinking skills is still a useful construct, however, both (a) because it makes this wide range of skills more coherent and easy to conceptualize and (b) because it makes it simpler to postulate and identify the appropriate domain specific divergent thinking skills that will be important within any given domain or microdomain. Thus in terms of what is happening inside a creative thinker's head, divergent thinking skill may actually be many unrelated, domain specific cognitive skills; but in terms of how psychologists can understand these many diverse skills (viewing divergent thinking from the outside, as it were), divergent thinking is a coherent class of skills that bear a strong family resemblance.

Moving from the implications of domain specificity for creativity theory to its implications for creativity testing, a domain specific understanding of creativity provides a very direct challenge to existing notions of how to test creativity. Simply put, to the extent that creativity is domain specific, creativity testing becomes that much more difficult. If creativity is domain specific, what exactly is one to test? Creativity testers will necessarily have to determine in which domain(s) of creativity they are interested, because under a domain specific theory of creativity, general creative thinking skill becomes an empty construct. Tests of creativity in specific content domains—which might use the Consensual Assessment Technique to evaluate the creativity of products, or might instead find simpler (perhaps paper-and-pencil) techniques for assessing domain specific skills—would still be possible in principle, but they could be of only limited range and applicability. Major test developers may not be willing to support extensive test development efforts for tests of such limited potential use.

Creativity training, on the other hand, can accommodate domain specificity of creativity rather easily. Most creativity training programs already use a wide variety of tasks, spread across various content domains, in the exercises they use to improve divergent thinking and other creative thinking skills. Creativity training programs aimed at a particular domain can easily limit their training exercises to ones connected to that domain, while programs aimed at increasing creativity in general—the vast majority of programs—must be careful not to limit their training exercises to just one or a few content domains.

Creativity theory has only recently begun to accommodate research evidence suggesting that creativity is task specific, although the hierarchical approach discussed above is promising. General, domain-transcending theories—if true—would have far greater power than domain specific theories that account only for creativity in a limited content domain. For this reason, and because creativity theories have historically been one-size-fits-all theories, domain general theories of creativity continue to have great appeal. Unfortunately, research suggests that creativity is domain general only to a very limited degree; for the most part, creativity appears to be domain specific.

It should be noted that the research evidence pointing toward domain specificity of creativity is fairly new, and, like the research that preceded it, this research may not tell the whole story. More research will be needed to clarify the conditions under which generality or specificity of creativity is the more valid perspective. In the meantime, both views will continue to claim adherents among researchers and theorists.

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Dreams[☆]

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Glossary

Creative The term “creative” can be applied to any act, idea, or product that changes or transforms an existing domain of human endeavor. A phenomenon is creative if it is novel and, in some manner, useful or appropriate for the situation in which it occurs. This concept is sometimes called “Big C” creativity. Creativity in dreams, in drug states, and while concentrating would be examples of “Little C” creativity, which also refers to everyday creativity

Creativity The English word “creativity” is linked, historically and etymologically, with the Latin word *create*, to make, and the ecclesiastical Latin word *creator* (Creator). Both refer to the concept of origin (consider the related term “originality”). Some writers discuss the “Four Ps” of creativity: Person, Place (also called Press), Process, and Product

Dream Report A dream report is a person’s description of a recalled dream, typically reported in narrative form. The dream may be recalled spontaneously or elicited by someone else, as in a laboratory setting

Dream A dream is a series of images that occurs during sleep. They are usually visual and kinesthetic but may be auditory or even gustatory or olfactory in nature

Electroencephalogram (EEG) An EEG is a graphic description of the brain’s electrical potentials recorded by scalp electrodes and usually delineated by ink tracings as are the **electromyogram (EMG)** (graph of muscular changes) and the **electro-oculogram (EOG)** (graph of eye movements)

Hypnagogia It refers to characteristic mental activity as a person is falling asleep.

Hypnopompia It refers to characteristic mental activity as a person is waking up.

Lucid Dream Reports These are characterized by a person’s claims that he or she was aware that he or she was dreaming of the ongoing dream

Nightmares These are dream reports characterized by intense anxiety, confusion, terror, and/or other unpleasant emotions

Non-REM Sleep It is characterized by an absence of **Rapid Eye Movement (REMs)**. It occurs in each of the four sleep stages, namely Stage One Sleep, which occurs immediately after sleep begins, characterized by low amplitude and high frequency brain wave EEG tracings; Stage One Sleep, Stage Two Sleep, Stage Three Sleep, and Stage Four Sleep, which are characterized by progressively higher amplitude and lower frequency EEG tracings. REM activity is confined to the first two sleep stages

Rapid Eye Movement (REM) Activity It is characterized by rapidly occurring conjugate, synchronized horizontal or vertical eye movements during sleep and, to a lesser extent, during napping, daydreaming, hypnotic imagery, and similar times when a person’s attention is turned inward rather than toward the external environment

Sleep It is the recurring period of relative physical and psychological disengagement from one’s environment, characterized by cyclical stages

Sleep Terrors (also called Night Terrors) These are episodic conditions, usually occurring during Stage Four Sleep. They are characterized by unpleasant emotions and a lack of imagery. They occur developmentally, most often in childhood

Wakefulness This is the recurring period of relative physical and psychological engagement with one’s environment

[☆] *Change History:* May 2019. Stanley Krippner updated the text throughout the article.

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Creativity, Dreams, and Culture

From the perspective of Western psychology, creative problem-solving is a process that can bring something new into being by someone (or group) who is aware of gaps in human knowledge, by identifying those limitations, searching for their solutions, and making guesses as to a potential resolution. This is followed by testing one's guesses (or hypotheses), producing something that fills the gap, and communicating the final product. Here we can see three of the "Four Ps" of creativity in action: Person, Process, and Product. The fourth P is Place, the culture in which creativity occurs, the culture that recognizes and supports the product, or the culture that rejects the product only to have its value be recognized in a later time and place. I would add a fifth P, Phenomenology – the subjective experience of the person engaged in creative work.

Dreams often play a vital role in creative problem-solving, helping to identify what is missing, searching for a solution, testing one's guesses, and formulating a product—a concept, object, or activity that meets human needs for survival, for enhanced work performance, for esthetic satisfaction, or for one's enjoyment. Examples would be a scientific discovery, a mathematical theorem, a philosophical insight, an artistic masterpiece, a military victory, or a diplomatic accomplishment. Creativity is a social construct, and the product's recognition by others depends on the culture in which it occurs.

Ullman, in 1965, listed four ways in which dreams can participate in the creative process. All dreams are original; no two are exactly alike. Dreams combine several images to form a novel narrative, one that is reported upon awakening (a process Freud called "secondary revision"). Dreams often contain images that are metaphors or symbols that convey the deeper meaning of those images. Hartmann (2012) adds that dreaming is more closely related to imagining than to perception, and is on the same continuum with a daydream, fantasy, reverie, or made-up story.

It is simplistic to call involuntary dreams "creative" because they do not intentionally create something. However, there are "lucid dreams" in which dreamers know that they are dreaming and make a creative effort.

Many indigenous cultures have appreciated the creative aspects of dreams. Among several Australian aboriginal tribes, it was believed that "The Laws of Dreaming" were laid down during what they call "The Creative Period." Each species has its own set of laws and all these laws, human and non-human alike, are part of "The Dreaming," the ground of all existence. From time to time, humans can obtain new information from "The Dreaming" and express it in songs, dances, and rituals. Hence, "The Dreaming" is dynamic, not static, in nature.

Shakespeare, in his play *The Tempest*, wrote about "such stuff as dreams are made on." He seemed to realize that dreams can mirror waking life, often using symbols and metaphors. Many dream images and activities directly represent the person or behavior in question. However, an image becomes a symbol when it has a deeper meaning, just as a dream activity becomes a metaphor when it conveys something not readily apparent. Freud (1900/1961) asserted that people dream in symbols and metaphors to guard themselves against unwelcome desires and drives. Adler (1958), one of Freud's contemporaries, broke with him on this issue, positing that dreams contain more positive than negative material. But both psychiatrists noted the continuity between dream life and wakefulness. This emphasis on dream/wakefulness continuity also can be found in the work of St. Thomas Aquinas, who wrote, "Those things that have occupied a man's thoughts while awake recur in his imagination while asleep."

This continuity is recognized by most contemporary dream researchers, such as Hall (1953), Domhoff (2018), and Foulkes (1985). The latter declared that dreams are meaningful but do not follow a preordained coded message that needs to be unveiled by a psychoanalyst. According to Foulkes, a dream is "knowledge-based" and is bound to reflect some of the ways in which the dreamer mentally represents his or her world. Foulkes continues to describe how almost anyone who is awakened from a dream is able "to identify some events as having rough parallels in her or his waking experience." There are many differences between waking cognition and dreaming cognition, but these differences are more continuous than discontinuous.

In 1979, Rycroft mused that if dreams are poetry, their efforts are imperfect. If they hope to have an audience, poets and artists cast their meaning in metaphors and symbols that are part of their culture's shared legacy. On the one hand, most dream imagery in contemporary Western cultures tends to be too dependent on the dreamer's personal experiences to have wide appeal. For example, dreams are sometimes turned into stories or movies during psychotherapy (Jenkins, 2012). However, dreams sometimes provide raw material for literature, as attested to by Robert Louis Stevenson, Steven King, William Styron, Amy Tam, and others (Ruprecht, 2007).

It should also be noted that many indigenous cultures have formulated their own repository of symbols and metaphors so that an elder can help a young dreamer fathom a dream's meaning (e.g., Lohmann, 2007). However, some pre-Columbian tribes held that a dream's meaning was dependent on the dreamer's personal concerns. There were tribes that stressed the problem-solving function of dreams, while other tribes saw them as forecasting future events. Some Native American cultures believed that dreams portrayed directions for the dreamer, while others thought that dreams depicted events in the spirit world. For some tribes, dreams about sex revealed "the secret desires of the soul," resembling Freud's concept of "wish fulfillment."

Among the Quechua of Peru, maize is a symbol for money, and potatoes for livestock. If someone dreamed that a stranger was asking to exchange potatoes for maize, the dreamer might check the safety of his cattle, suspecting that a rustler might be in the neighborhood. Among the Toraja of Indonesia, personal dream symbols are common, as this is a society that grants considerable personal authority to its members. As a result, there may be disagreements about a dream's meaning, and a discussion is needed to reach a resolution. The Toraja frequently assign meanings to dreams based on reversals; if a person of high status has a nightmare, this is seen as a confirmation of the dreamer's authority.

All these indigenous perspectives stand in sharp contrast to Crick and Mitchison's 1983 proposal that dreams function to purge unnecessary, even parasitic, brain cell connections produced during wakefulness. Thus, dream content is best off forgotten. But

other dream researchers agree with Hobson (1988) that dream images are random and accidental. Even so, the ability of the sleeping brain to work those images into a coherent story stands as a testimony to the universality of esthetic experience. In dreams, he noted, everyone can become a writer, a painter, or a film-maker, combining extraordinary sets of characters, actions, and locations into strangely coherent experiences. In 1988, he wrote "I strongly object to any implication that the artistic experiences of waking or dreaming are fundamentally pathological, defensive, or neurotic The brain is so determined to find meaning that it creates dreams out of images that have been randomly evoked by its own neurochemical activity."

Research on Creativity and Dreams

Weisberg, in 2006, stated that creative problem-solving has occurred when a person produces a novel response that solves a problem at hand. He went on to debunk some highly publicized examples of creativity in dreams and other alterations in consciousness. A critical perspective needs to be taken regarding not only anecdotal accounts but also structured research programs. Creativity in dreams is a phenomenon that is difficult to investigate for several reasons. A researcher does not work with dreams but with dream reports. These reports, whether obtained from archives, from field research, or from a sleep laboratory, are subject to vagaries of memory, unconscious (or deliberate) distortion and elaboration, and semantic issues (the researcher and the participant may differ on the meaning they attribute to key words). Researchers in this area need to maintain a sense of modesty when announcing the results of their work.

Anecdotal Data. Keeping Weisberg's caveat in mind, many reports of creativity in dreams have not been challenged. They include Howe's invention of the lock-stitch sewing machine, Blake's development of a copper engraving process that he later used to illustrate his songs, Tartini's composition of his most celebrated sonata, and fictional work by Robert Louis Stevenson and Daphne du Maurier, among others. The mathematician Jerome Cardan credited a recurring dream for his most widely read work, *De Subtilitate Rerum*. Whenever Cardan became lax in his writing habits, his dream would return with great force. Carl Jung's creative approach to the study of dreams was acknowledged for decades, but his artistic creativity was not apparent until the posthumous publication of *The Red Book*, in which he illustrated his dreams and other manifestations of his inner life.

Some contemporary writers credit their dreams with characters and plot developments (e.g., Almansi and Begun, 1986). Stephen King revealed that he used one of his own nightmares in one of his novels. Isabel Allende was inspired to write *The House of Spirits* by her dreams. However, she was unable to bring the novel to a satisfactory conclusion until she had a dream about her grandfather that produced a perfect ending. William Styron was working on other projects when he dreamed about a young woman who had been an acquaintance several years earlier. Her charisma in the dream was so powerful that Styron dropped all other work to focus on writing *Sophie's Choice*, one of his most successful novels and one in which the central character's struggles had little to do with the woman who inspired the dream (Rupprecht, 2007). Two well-known "beat" writers, W.S. Burroughs (1995) and Jack Kerouac (1971), wrote books based on collections of their dreams.

In 2017, Webb produced a compendium of several dozen popular songs that originated in dreams. Among them was Paul McCartney's "Yesterday," the most re-recorded song of modern times. The melody was so complex that McCartney initially thought that he had copied someone else's work. Barry Manilow claimed that dreamed about his song "One Voice" in complete form. Sting shared that the title of "Every Breath You Take" originated in a dream; waking up, he finished the song in half an hour. On the other hand, Johnny Cash said that his song "The Man Comes Around" originated in a dream about Queen Elizabeth II. Billy Joel once stated, "I dream music all the time"; his dream-inspired album "The Stranger" won a Grammy for the Album of the Year.

In a discussion about his dreams, Sting provided an intriguing account of his creative process while composing songs for his album "The Wild Wild Sea. A song may begin as "disjointed fragments recalled from a night of fitful sleep." He turned the dream vignettes into song, often re-entering "that realm that is halfway between sleep and waking." Dream researchers call this realm "hypnagogia" if it occurs while one is falling asleep and "hypnopompia" if it occurs when one is awakening. Mary Shelley attributed her novel *Frankenstein* to hypnagogic images she had after her host challenged his guests to produce a ghost story. Mary Shelley won the contest and eternal fame.

Many creativity researchers use a framework of preparation, incubation, inspiration, and verification in their analysis of anecdotal reports. Creativity, of course, may not follow such a linear progression, but when it does, a dream might provide the inspiration following a period of conscious and unconscious incubation. Often, one's deliberate attempts to solve a problem might be fruitless, but these efforts are abandoned during sleep. Dreams can impart clues and novel approaches that have been elusive during wakefulness. It may be the case that similar results could occur simply by taking a break. Incubation still might be taking place until the sudden (or gradual) inspirational insight occurs. Mary Shelley's preparation for her famous novel occurred long before she knew about the contest; she was familiar with the "Gothic" takes of that era. Once the contest was announced, it was likely that she unconsciously began to pull together an engaging narrative. Inspiration resulted in her hypnagogic images, and winning the contest was the verification of her narrative.

Formal Research Data. Several investigators have used tests, questionnaires, and interviews to obtain information about creative problem-solving in dreams. An experiment reported by Brodsky, Esquerre, and Jackson in 1991 asked participants, while they were awake, to apply an operational definition of dreaming to four problem-solving tasks. All proposed solutions were rated on a five-point scale by raters, working independently. No gender differences were noted nor was frequency of recalled dreams associated with the creativity ratings. However, participants who attributed considerable importance to their dreams received higher creativity

scores, as did participants who reported having had lucid dreams. The researchers suggested that dreaming is a “permission-giving” format for eliciting active imagination, bypassing typical goal-oriented cognitive processing.

A series of experiments reported by Cartwright (2010) demonstrated that problem-solving in dreams is more successful when the material to be processed is either emotionally relevant or personally meaningful. Hartmann (1991) found that people with “thin boundaries” (a personality trait) are more likely to have nightmares and to be associated with the arts. A questionnaire study of college students conducted by Hartmann found that art majors reported the most nightmares, while physical education majors reported the fewest. Students who had frequent nightmares had more visual imagery upon awakening, became easily absorbed in aesthetic stimuli, and demonstrated high hypnotizability.

In 1970, Hall and Lind used the content analysis method to study the writer Franz Kafka’s 37 recorded dreams. They found personality traits consistent with what is known about Kafka, demonstrating the “continuity between dreams and waking life.” Hall and Van de Castle (1966) had developed content analysis after collecting some five thousand dreams and noting the frequency of common dream images. Music or sound appeared in only 1.5% of those dreams. So, it is quite remarkable that so many composers, both classical and popular, found a link between their dreams and their work. Richard Wagner not only received inspiration for his operas from dreams but even had his own dream theories. Some of them involved what Freud was later to refer to as “condensation,” in which a dream can incorporate several elements. Beethoven, Schubert, Schumann, Brahms, Berlioz, Bruckner, and Stravinsky all credited some of their compositions to dreams (Webb, 2017).

Possible Mechanisms

Contemporary sleep and dream research has demonstrated the elaborate, intrinsic mechanisms of “state” control. In other words, a change in the brain’s state while asleep changes the dreamer’s phenomenology. Sensory input can be internally controlled so that even the transforming mechanisms do not operate alone to protect the system from overload. Three features of contemporary conception of the nervous system – its intrinsic plasticity, its auto-regulation, and its creativity – provide a very different set of operating principles upon which to construct a scientific psychology of sleep and dreaming. This perspective proposes a nervous system that can turn itself on and off, regulate the flow of internal information in diverse ways, and control external information’s access to the system. It is in the context of this model that the incorporation of pre-sleep stimuli, dream incubation, and lucid dreaming assumes importance for the understanding of creativity and dreams.

Incorporation of Pre-sleep Stimuli

The influence of pre-sleep stimuli in dream content has been successfully demonstrated in experiments using hypnosis, subliminal stimulation, emotionally arousing films, and real-life stress situations. The results indicate that it is relatively easy to influence dream content in predictable ways. For example, Cartwright (2010) found that reaction to pre-sleep stimulation (such as that provided by erotic films) elicited dreams that provided emotional support for the dreamer’s reaction to the stimuli. Dreams may assimilate emotionally arousing information into problem-solving solutions that are already embodied in existing memory systems.

Dream Incubation

Serapis was the Egyptian god of dreams, and several temples were devoted to his worship, some of them dating back to 3000 BCE. In ancient Greece, over 400 temples were dedicated to Aesculapius, the god of healing and the intermediary of dream incubation. A citizen was not allowed to drink alcoholic beverages for three days before entering a dream temple, because it was believed that useful dreams were unlikely to occur while the dreamer was under the influence of alcohol (a sentiment that is backed up by research demonstrating that alcohol drastically reduces REM sleep).

Dream incubation was common among the American Plains Indians. Upon entering adolescence, an Indian boy would retire to a solitary location, incubating a dream about the identification of his guardian spirit or totem animal. An eagle or bear was often interpreted as the sign of becoming a future warrior, a wolf of becoming a successful hunter, a serpent of becoming a future medicine man. However, different tribes attributed different meanings to the appearance of these creatures in dreams. In ancient China there was a tradition of dream incubation among artists. For example, in the ninth century, Kwan Hiu regularly engaged in a ritual of prayer to a holy person before falling asleep. He was rewarded by a dream of the saint, awakened with the dream image in mind, and proceeded to paint it.

The neurologist W. B. Cannon stated that he had rarely gone to bed preoccupied by a problem without the solution being in his grasp when he woke up the next morning. The mathematician and philosopher Bertrand Russell would often work on an abstract mathematical problem to the point of exhaustion, and then go to sleep. He claimed that the answer to his problem would frequently occur in a dream. The artist Giorgio de Chirico referred to his dreams as a “source of inspiration” and advised “constant control of ... all the images that present themselves to our minds.” The surrealist Salvador Dali also claimed to have had a remarkable ability to induce and utilize his dreams, as did William Blake and Paul Klee (Barrett, 2001).

Foulkes (1985) moved from the anecdotal level to more rigorous types of inquiry, teaching 23 participants “dream control” methods, and asking them to dream about randomly selected topics. The participants kept daily records of their dreams for 10 nights. Judges attempted to match dreams with the suggested targets, but their matchings did not exceed what would have been expected by chance. The same investigators designed a second study using 29 highly motivated participants who claimed some previous success in dream control or an interest in the topic. They spent 10 nights attempting to dream about assigned topics, but once again, judges were unable to match the dreams with the topics.

However, Reed and Van De Castle have reported more encouraging results in projects in which incubated dreams focused on real-life concerns, not on abstract topics, but on real-life concerns (Van de Castle, 1994). Barrett (2001), Delaney (1990), and Garfield (1974), all former presidents of the International Association for the Study of Dreams, have cited case reports indicating how dreams can help many people live more fully integrated lives and augment their capacity for adaptation and personal growth.

Lucid Dreaming

When dreamers realize that they are dreaming, the dream is called “lucid.” The Tibetan Buddhist practice of “dream yoga” focused on the ability to remain aware and lucid during nighttime dreaming. However, the Hindu yogic dream tradition eschewed such dream manipulation in favor of a waking meditation practice described as “merging with the light.” Aristotle wrote about dreams in which “the sleeper perceives that he is asleep and is conscious of the sleeping state during which the perception comes before his mind.” In the second edition of *The Interpretation of Dreams*, published in 1909, Freud noted that some people are clearly aware when they are dreaming, and can direct their dreams.

Firsthand reports from lucid dreamers have produced several methods thought to be useful in facilitating the experience. Asking such critical questions as “Is this a dream?” and “Am I dreaming?” during a dream will often produce lucidity. Some dream workers encourage people to ask these questions during the day at regular intervals, with the expectation that these questions will later arise during the night. Specific skills are sometimes learned in lucid dreams. Jack Nicklaus, after winning several golf championships, found himself in a slump. He regained his form after learning a new golf stroke in a lucid dream. Researchers estimate that half the population of the United States experience a lucid dream at least once, while one in five report HAVING one each month. Lucid dreaming has been used therapeutically, especially to help people suffering from repetitive nightmares (Krippner et al., 2002).

Neurophysiological and Neurochemical Mechanisms

Several studies with non-human animals indicate that the amount of time spent in REM sleep increases as a result of new learning, such as finding the way out of a maze. This relationship is evident in work conducted with cats, mice, rats, and newly hatched chicks. Therefore, REM sleep may play an important role in the consolidation of such cognitive activities as learning, memory, and problem-solving for both humans and other organisms that engage in REM sleep. New protein structures are synthesized in the brain during REM sleep and could well be the forerunners of creative change in how dreamers view themselves and their world. The evidence indicates that the initiation of REM sleep comes from the brainstem, then extends itself over the entire brain cortex.

Some theorists have used computer analogies to describe REM functioning as akin to “off-line processing” in computer science. The acquisition of input information is temporarily stored in computer-like memory until processing components are available. Information about the day’s events is gathered and stored until the onset of REM sleep when it can be “processed,” integrated with memories, and formed into strategies for the future. It is hypothesized that EEG theta rhythms associated with hippocampus activity during REM sleep signals that information processing and future planning are taking place.

The spiny anteater, or echidna, is an early mammal whose sleep pattern shows no REM activity. The echidna’s brain, however, has a large prefrontal cortex, presumably to integrate new experience with older experience. The mammals that evolved later were able to handle this task more efficiently during REM sleep; as a result, their brains were smaller – a more efficient direction for evolution to follow. This problem did not exist in the earlier reptilian species; their behavior was largely reflexive, and this activity was adequately handled by a small brain with a neocortex. Dreams, then, can serve as a window on the neural processes whereby – from early childhood on – strategies for behavior are being set down, modified, or consulted. This process and the mechanisms involved were termed the “unconscious” by Freud and can be used advantageously in the clinical setting by both Freudian and non-Freudian psychotherapists and other dream workers.

Hobson proposed that cells deep in the pontine area of the brain stem are periodically activated during sleep, generating REM sleep and randomly stimulating the forebrain, which then synthesizes dreams by using stored memories to make sense of the incoming neural firing. On the one hand, Hobson reduces dreaming to biochemical events in the brain, but on the other hand, he has a keen understanding of dreams as imaginative creative events.

Hobson points out that Freud insisted that wishes and repressed desires caused dreaming but that this notion has been discredited due to data that brainstem mechanisms during sleep cause dreaming. Once these mechanisms trigger REM sleep (and dreaming), wishes may be expressed and may even shape dream plots, but they are in no sense causative of the dream process.

Hobson's model proposes that during both waking and dreaming there is an activation of the brain, an information source that is evoked, and a biochemical modulation that differs radically from wakefulness to sleep. Dream experiences, in part, are a product of the brain's self-organization during which the randomly evoked information is patterned into a narrative to which meaning can be attributed. The cells in the brain's pontine area are activated, generating REM sleep and stimulating the forebrain, which then makes sense of the results of the neural firing. Like other subjective experience, dream material tends to be organized by the linguistic faculty of the brain. Thus, Hobson concludes that dreams are not the result of an attempt to disguise repressed wishes but are a direct expression of a synthetic effort. Even though Hobson disagreed with Freud regarding the origin of dreams, he concurred that dreams are the "royal road" to a scientific understanding of consciousness.

Hobson's model is seen as unduly reductionist by those researchers who hold that REM sleep and dreaming are two separate processes. Foulkes has presented laboratory data indicating that considerable mental activity occurs outside of REM sleep, even though the quality of non-REM mentation is quite different. Non-REM dreams also play a role in memory consolidation, but mainly for recent events. Krippner and Combs (2002) have noted that in both REM and non-REM dreams the formal analysis of activity patterns in complex neural networks can be carried out in terms of chaotic attractors. They proposed that the dreaming brain "relaxes" into patterns of self-organized neural activity that often reflect the residual moods, stresses, and concerns of everyday life. In the creative process, small changes in cognition or behavior can trigger an avalanche of novel creative products. This "butterfly effect" characterizes many dreams that lead to a creative solution to an ongoing program. Krippner and Combs agree with Hobson that the brain's self-organization capacity is apparent in dreams but suspect that there is a data bank of "personal myths" that is utilized in the resulting narrative.

Cartwright (2010) adds that the dreaming process has a remarkable access to memories and emotions. Dreams are not constrained by the realities of waking life, thus allowing mental processes to work unhindered with these materials, to experiment, and to create until answers arrive. But problem-solving in dreams is not limited to mechanical, scientific, or artistic participants. Even more common are dreams that help with emotional dilemmas. Cartwright and Lamberg, in 1992, drew upon the dream research literature to propose ways in which psychotherapists, counselors, and dreamers themselves could recall and utilize dreams to overcome depression and anxiety brought about by divorce, bereavement, serious illness, and job loss. In fact, the very process of dreaming about such difficulties seems to be a creative remedy for the dreamer's emotional pressures.

Further Research

Arieti (1958) cogently stated a critical issue underlying the relationship between dreams and creativity, proposing that dreams are often original, but they are not fully creative. For dreamers, the impact of the customary environment is removed, and the dreamer places few if any restraints on dream content. Unexpected connections occur. Some combinations of scenes and events take place that have never occurred either in nature or in the dreams of other people. But the same can be said of some schizophrenic ideation! However, the schizophrenic is unprepared to utilize original, unusual, and bizarre ideation in crafting creative products. And sometimes, a dream can be extraordinarily complex; Arieti reports the case of Antonio Ludovico Muratori, an 18th century scholar, who dreamed about composing a Latin verse, a pentameter that ordinarily would require complex use of metric technique. But, to Arieti, this is the exception that proves the rule; for him, it is important to distinguish between originality, "ordinary creativity" (what Richards has called "everyday creativity"), and "great creativity" which may have a great impact upon the future of human society.

The field of dream research is extraordinarily rich, connecting to several other disciplines. Future research studies need to identify the genetic markers for creative behavior, reconcile personality and cognitive research data in creativity, evaluate the part played by the dreaming process in creative ideation, determine the role of mental illness in blocking or facilitating creative expression, and specify what home and school variables are key factors in the development of highly creative individuals.

It is apparent that individual differences exist in dream creativity, and that there are cultural differences as well. The vast preponderance of studies in the field are devoted to the neurophysiology and neurochemistry of sleep and dreaming as opposed to the psychosocial variables in dreaming, and, of the latter, only a handful concern themselves with creative aspects of dreaming despite the near-consensus of dream researchers that the two phenomena are linked in several ways.

The unanswered questions posed by existing research data are legion, for example, why is color spontaneously reported in the dreams of half of art students studied, 16% of the science majors, and virtually none of the engineering students? Why do subjects, in general, tend to report color in their dreams more frequently if they claim to place greater reliance on feelings than on thinking? In laboratory studies, why does recall of color in dreams disappear quickly if the investigator does not ask for it? What is the nature of dreams in which color is greatly intensified, radiating with phosphorescent hues? What is the nature of dreams that a dreamer who almost always dreams in color swears have occurred in black and white? What are the mechanisms that determine shifts in dream color when people wear colored goggles during every waking moment for a week? Why do members of some cultural and social groups report more and different colors in dreams than do others? Why do children report more color in dreams than adults?

The answers to these questions can be sought from psychosocial, neurophysiological, neurochemical, and phenomenological investigations, as can answers to dozens of additional questions relating to creativity in dreams. In the meantime, for the Australian aborigines, the Amazon Kagwahiv, and other tribal people, the "Dreamtime" and "The Dreaming" still exist. They believe that if

other human beings would begin to make their own dream journeys, reestablish their links with Nature, and creatively invoke Dreamtime songs and dances, many of the world's current dichotomies and discontinuities could become accommodated and transcended. For both the mind/brain and the individual/group, this has been one of dreams' creative functions over the millennia. The need for creative solutions to the world's many social, economic, and environmental problems reflects the importance of creativity, and of the researchers and dream workers who see creativity in dreams as a critical frontier in understanding and assisting human development in a world – and a species – currently at risk.

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Drugs

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Introduction

Many stories, both positive and negative, are in the popular culture regarding the relationship between drugs and creativity. But what is the reality? Do drugs enhance or deter creativity? This entry will review some historical literature regarding creativity and the use of a variety of drugs including cannabis and hashish, cocaine, Lysergic Acid Diethylamide (LSD), opium, psilocin, and psilocybin. Then the research regarding creativity and these drugs will be reviewed. Finally, the relationship between creativity and prescription drugs will be discussed.

Drug Use and Research

Opium was used by doctors in Greece in 100 BC. In North America, drug use dates back to native tribes in the United States and Mexico who took mushrooms and peyote within the context of religious ceremonies. Coca leaves were used by natives as a part of social life, work, and worship for thousands of years in South America. These drugs were a part of the cultural fabric and have a genuine spiritual connotation for many practitioners.

Traditional and newer man-made prescription drugs have contributed to a situation where substance dependence and abuse have become widespread. The United Nations Office of Crime and Drugs The World Drug Report (2018) stated that globally 275 million people (5.6%) used drugs in 2016 and 31 million suffered enough harm that they needed treatment. Drug and alcohol use trends downward as people get older but for addicts use can increase as more of the substance is needed to generate a high.

Concrete statistics on drug use among creative people is scant. Anecdotal evidence based on public disclosure indicates it is above the norm, but objective studies that delineate the relationship between creativity and drugs are difficult because it varies so much by individual and many eminent creative people are understandably reluctant to discuss it publicly.

Nevertheless it is clear that some creative professions participate in drug subcultures which vary according to the type of drug. Radenkova-Saeva (2008) defined drug subcultures as “groups of people loosely united by a common understanding of the meaning and value (good or otherwise) of the incorporation into life of the drug in question” (p. 22). These groups often form friendships that involve taking “the drug together, possibly obeying certain rules of etiquette, to full-scale political movements for the reform of drug laws. The sum of these parts can be considered an individual drug’s culture” (p. 22).

Examples of psychedelic art in a variety of domains will be discussed below. According to Krippner (2017), “psychedelic art” is not defined by its content but by a certain type of experience (or experiences) that have affected and impacted the artist. These experiences were evoked by substances variously called “psychedelic” (“mind-manifesting”), “entheogenic” (“evoking the divine within”), “hallucinogenic,” or even “psychotomimetic” (“among others”) (p. 416). Krippner (2017) interviewed 189 artists and writers in a study regarding the use of psychedelics in the late 1960’s and early 70’s. He found that taking the drugs influenced the content, approach, and technique of their work. For musicians drug use influenced lyrics, texture, and mood.

Cannabis and Hashish

Cannabis (also known as marijuana, weed, pot, etc.), are the buds and leaves of the Indian hemp plant. THC is a psychoactive chemical found in the plant which causes relaxation and reduced short-term memory. Continued use may result in increased anxiety and paranoia in some individuals.

Cannabis is a milder form of intoxicant than hashish which is a hardened form of cannabis that is eight times stronger. Cannabis was used as early as 3000 BC in Egypt and was used up until the 20th century before it was made illegal in most countries. Presently there are some countries where cannabis is legal, including Canada, The Netherlands, Spain, etc. In some countries, it is illegal but the law is not enforced and in other countries the use of medical marijuana is permitted. The United States is moving toward legalization with 15 states where it is legal in 2020.

Louis Armstrong started smoking in the 1920s and used it all his life on a daily basis. He even planned to write a book about it called *Gage* but his manager thought it was a bad idea and the manuscript was put away. Armstrong was arrested once for possession but never went to jail. Actor Robert Mitchum was not as lucky—he spent two months in the Los Angeles county jail for possession.

In the 1960s and 1970s marijuana became a commonly used drug as it still is today. The pot subculture includes hundreds of pop songs that praise grass. Stoner movies became a minor genre which included *Up in Smoke* starring Cheech and Chong, *Pineapple Express* and *Harold and Kumar go to White Castle*. Sean Penn became a star playing a stoner in *Fast Times at Ridgemont High*.

While in the 90's Bill Clinton claimed he never inhaled, Barack Obama felt free to mention he smoked grass in his autobiography. Richard Branson, the Chairman of Virgin Airlines and Presidential candidate Michael Bloomberg of New York also publicly disclosed they had used grass. Some creative individuals such as comic Bill Maher and Willie Nelson became elder statesmen of pot publicly discussing the fact that they smoked cannabis regularly although Nelson recently announced he was stopping his use for health reasons.

Opium and Heroin

Perhaps the oldest drug is opium which is produced using seeds from the opium poppy. Opiates include opium, morphine, and heroin which work on the brain and spinal cord lessening pain and creating a feeling of euphoria. Smoking opium did not come into vogue until the discovery of Indians smoking tobacco.

Symphony Fantastique by Hector Berlioz is an example of a classic work inspired by his opium use. The story is based on Berlioz's unrequited love for an Irish actress named Henrietta Smithson. Movements 4 and 5 occur after a young musician poisons himself in despair and experiences strange visions which are translated into his music. Smithson had left for London when Berlioz wrote the symphony but by the time it was performed she returned to Paris and attended it's opening by chance. Berlioz ended up captivating her heart and marrying her but sadly the marriage did not work out.

Charles Baudelaire, the French poet, and Alexander Dumas belonged to The Club des Hashischins where hashish was taken every month at séances. Baudelaire clearly had addiction problems with alcohol and opium as well as hashish that may have contributed to his death. Coleridge is alleged to have written the *Kubla Kahn* under the influence of opium. Other famous opium users include Elizabeth Barrett Browning, Sir Walter Scott, and W. B. Yeats.

Escaping from the confines of life was used as an explanation for his opium use by Cocteau. Baudelaire wrote:

Opium magnifies that which is limitless
Lengthens the unlimited
Makes time deeper, hollows out voluptuousness
And with dark, gloomy pleasure
Fills the soul beyond capacity

Quoted in Largo, 2008: 24

By the 20th century stronger forms of opium including heroin had been concocted. A heroin subculture became prevalent in the jazz community from the 1930s to the 1960s. Talented musicians such as Billie Holliday, Charlie "Bird" Parker, and Chet Baker's deaths were related to heroin. Others such as Miles Davis whose album *Birth of The Cool* is considered the best in history by many as well as Ray Charles also used heroin. Rock stars Janis Joplin, Jim Morrison, and Kurt Cobain died from heroin or morphine overdoses along with many others. Comics Lenny Bruce, John Belushi, and John Candy also died of drug overdoses. Lenny Bruce said: "I'll die young but, it's like kissing God." Movie biographies of musicians who became hooked on some type of drug have become a genre.

Cocaine

Cocaine is a concentrated form of coca leaves which is usually snorted and absorbed quickly. It creates a very intense high. Eventually cocaine addiction can lead to severe problems in the nasal cavity, along with paranoia and insomnia.

Sigmund Freud wrote a paper called *Uber Cola* in which he experimented on himself a *dozen times* and noted the “exhilaration and lasting euphoria.” He later changed his mind about benefits when a friend died from an overdose. Other prominent creative individuals who used cocaine include Elton John, Stevie Nicks, and Isadora Duncan.

Dr Jekyll and Mr. Hyde is thought to be at least subconsciously about drug use and personality change. Robert Louis Stevenson was a cocaine addict who allegedly wrote the book while using. Sir Arthur Conan Doyle depicted the destructive aspects of cocaine in Sherlock Holmes who became addicted. Nelson Algren’s *Man with The Golden Arm* about a morphine addict won the National Book Award and was made into a movie starring Frank Sinatra.

Lysergic Acid Diethylamide (LSD)

Albert Hoffman, a research chemist, had a hunch that lysergic acid diethylamide (LSD) might have some special properties in 1943. In his book, *LSD: My Problem Child*, he described what happened when he was preparing some concentrated LSD for the first time. He suddenly became dizzy and felt he had to go home and lie down. In the next two hours he experienced intense colors, fantastic pictures and a pleasant intoxication. Hoffman knew he was on to something special and likened his recognition to Louis Pasteur who said, “luck only happens to those who are prepared.”

Hoffman’s experience inspired interest into researching the power of LSD by psychiatrists working with schizophrenia, alcoholism, and patients in therapy. Oscar Janiger completed an 8½ year study in Los Angeles which ended in 1962. He eventually recruited 930 individuals; initially half were in psychotherapy and half were in the general population. So many professional artists volunteered that he added a substudy. Janiger discovered artists “somehow found a way to harness the LSD state to the creation of art and were able to increasingly control the physical expression of their subjective experiences” (de Rios and Janiger, 2003, p. 24). According to de Rios and Janiger: “The heightened aesthetic sensibilities of the psychedelic experience clearly broaden the individual’s subjective sensitivities. In the great majority of reports we see instances in which moral values were affirmed, emotional conflicts were resolved, and participants appear to have been better able to cope with human predicaments” (p. 42).

There was also a strong spiritual component—24% of participants experienced “a mystical or spiritual encounter” (p. 115). No negative effects were reported. One of the subjects, movie star Clark Gable, talked openly about how he had a psychological breakthrough with the help of LSD. Later another movie star, Cary Grant, spoke about how taking LSD under a therapist’s supervision was a positive turning point in his life.

In 1963 LSD moved out of the lab and into the popular culture with a huge splash as Timothy Leary and Richard Alpert were thrown out of Harvard for advocating LSD use for everybody. By 1965 it was illegal in California but the genie was out of the bottle. Acid helped inspire the hippie movement which began with the summer of love in San Francisco and continues in spirit today at the Burning Man festival.

John Lennon and Paul McCartney were initially reluctant to discuss having taken acid but later stated that Beatles songs inspired by acid included *Lucy in The Sky with Diamonds*, *Magical Mystery Tour* and *Day Tripper*. Other groups contributed to a genre called psychedelic rock which included some of the biggest stars of the time including The Grateful Dead, The Jimi Hendrix Experience, Pink Floyd, and Jefferson Airplane. Jim Morrison named his band The Doors after the *The Doors of Perception*, Aldous Huxley’s book about mescaline. Brian Wilson of the Beach Boys took LSD which probably influenced *Good Vibrations*.

Ken Kesey toured the country in a colorful old bus taking acid which helped inspire *One Flew Over The Cuckoo’s Nest*. The film won 5 Academy Awards including best actor for Jack Nicholson, who had his own personal experience with LSD which inspired the writing of a movie entitled *The Trip*. Tom Wolfe wrote the best seller *The Electric Kool-Aid Acid Test* about Kesey.

Among other notable individuals who said LSD had an important influence on their life was Steve Jobs, the most creative executive of his time and Steve Wozniak, his partner who designed the first Apple computer. Scientists include Kary Mullins, a biochemist who claimed that taking LSD helped him recognize the polymerase chain reaction in DNA which won him the Nobel Prize and Sir Francis Crick “who told several friends that the double helix of DNA came to him in an LSD session” (Krippner, 2017, p. 428).

Psilocin and Psilocybin and Ayahuasca

Initially used by the Aztec Indians, “magic mushrooms” became popular during the 60’s. However they were used as part of traditional spiritual ceremonies dating back to 1500 BC: “In Mexico and Central America, stone sculptures...portray mushrooms from whose stems emerge the heads of deities” (Krippner, 2017, 57).

Ayahuasca, a tea made from the *Banisteriopsis caapi* and *Psychotria viridis* plants, was also used by Indians in Brazil in religious ceremonies. Like LSD, some individuals who took hallucinogenic mushrooms and ayahuasca reported having mystical experiences that significantly improved their lives, including their creativity.

A Summary of the Research

A simple summary listing the definitive results of drug use and creativity would ideally be presented here; however the research simply isn’t that conclusive yet. For example, in studies on cannabis In 2018, Iszai and his colleagues conducted semi-structured

interviews with 72 artists about the use of cannabis and alcohol in their work and for pleasure. They “found that for some artists, substance use is not only characteristic to creation, but it is also part of their everyday lives.” (p. 1275) The artists felt that alcohol and cannabis helped their creative process. However, a randomized double-blind study by Kowal and his associates in 2015 indicated that participants who took lower doses of cannabis didn’t experience any change in creativity while “highly potent cannabis actually *impairs* divergent thinking” (p. 1123).

Interestingly, one theory is that it may not be the cannabis that make users more creative but that people who are more creative choose to use Cannabis. [LaFrance and Cuttler \(2017\)](#) examined whether cannabis users big 5 personality characteristics contributed to the measurements of creativity by having 412 cannabis users and 309 non-user complete measures of their personality as well as objective and subjective creativity. They found that the “while cannabis users appear to demonstrate enhanced creativity, these effects are an artifact of their heightened levels of openness to experience” (p. 56). A smaller study by [Jones et al. \(2009\)](#) indicated that cannabis users produced a significantly higher number of rare-creative responses than controls.

Psychedelic research was banned for many years but recently there has been increased interest in looking at the potential benefits of microdosing on mental health and creativity: “Recent studies on full-dose psychedelic psychotherapy reveal promising benefits for mental well-being, especially for depression and end-of-life anxiety. While full-dose therapies include perception-distorting properties, microdosing may provide complementary clinical benefits using lower-risk, non-hallucinogenic doses” ([Anderson et al., 2019](#), p. 731). [Anderson et al. \(2019\)](#) completed a quantitative study with 909 participants recruited on Facebook, Twitter, and Reddit. They found that microdosing participants in their study scored significantly higher on the Unusual Uses Task than non-users. [Prochazkova et al. \(2018\)](#) completed a study with the Dutch Psychedelic Society using psychedelic truffles in which participants completed the Picture Concept Test and Alternative Uses Task which both are related to creative problem solving. Participants (55) who took psilocybin showed improvements in divergent thinking and emotional empathy in a study by [Mason et al. \(2019\)](#). Importantly those improvements persisted the next morning in 50 of the 55 participants and seven days later in 22 of the participants.

The possibilities for psychedelic research are improving as some promising results encourage governments to allow more testing of substances that were previously banned. (For review of psychedelic research see *How to Change Your Mind*, 2018).

Prescription Drugs

Prescription drugs including painkillers, sedatives and tranquilizers, and stimulants have been abused for many years. Drugs such as Opioids, Valium, Xanax, Vicodin, OxyContin, and methadone show up frequently in ER emergency situations. In a National Survey more than six million Americans over the age of 12 stated they used prescription drugs for nonmedical uses. None of the drugs mentioned above were positively associated with creativity. However they have been a part of the creative culture, particularly in the music and film industry. Prescription drugs have been implicated in the deaths of a number of eminent creative people including Marilyn Monroe, Jimi Hendrix, Elvis Presley, Heath Ledger, Prince and Michael Jackson among many others.

More investigation is needed to determine the influence of Lithium, often prescribed for bipolar individuals. A metaanalysis of 12 studies including 276 participants taking lithium and 263 similar participants indicated “small but significant” impairment in creativity ([Wingo et al., 2009](#)). Other studies indicated that some individuals with manic depression reported improvement in their creativity, especially in combination with psychotherapy. There is even less research available regarding antidepressants which is surprising given the statistics indicating depression is much more prevalent in many creative individuals than the general population.

One prescription drug may positively influence creativity. [Inzelberg \(2013\)](#) reported that levodopa and dopamine agonists apparently increased artistic talent in patients with Parkinson’s Disease (PD). [Faust-Socher et al. \(2014\)](#) found that 27 patients taking this medication showed “demonstrated enhanced verbal and visual creativity as compared to neurologically healthy controls ... Dopaminergic agents might act through the reduction of latent inhibition, resulting in widening of the associative network and enriched divergent thinking” (p. 935). It is important to note that these drugs have detrimental long term side-effect.

Conclusion

Theories about why the use of drugs and alcohol are more prevalent in creative professions include genetic predisposition, self-medication, opportunity, subculture, the difficulty of the work, the stress of success, as an aid to help their work, widening their consciousness and seeking a spiritual experience.

While conclusions regarding drugs and creativity are very tentative at this point, there are indications that under some circumstances a few drugs may enhance both the expectation of improved creativity as well as creative performance. However much remains to be discovered regarding both the short and long term positive and negative effects. Hopefully the fact that researchers have more freedom to examine the interactions will lead to more definitive answers.

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Dual Process

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Introduction

A cognitive science approach to understanding creativity will allow for the explication of the creative process on a step-by-step basis. In understanding the cognitive processes underlying creativity, it is helpful to consider broader theoretical frameworks from the area of thinking and reasoning. Dual process approaches to thinking and reasoning have posited the concepts of Type 1 thinking (fast, automatic) and Type 2 thinking (slow, deliberative). Within the last decade there has been increased interest in the role of these two types of thinking, and how they interact, in the process of creative cognition.

Dual Processes in Thinking and Reasoning

Research in the cognitive psychology of reasoning has led to the conclusion that thinking can vary in the extent to which it proceeds slowly, in a deliberative manner, typically constrained by working memory, or more quickly, intuitively or even in an unconscious or cognitively impenetrable manner. Consider the question below:

A bat and a ball cost \$1.10.

The bat costs \$1.00 more than the ball.

How much does the ball cost? ____cents

See Frederick (2005, p. 26).

The answer “10 cents” often occurs to people immediately, perhaps because in similar problems of this nature one simply subtracts one figure from the other. However, evaluation of this response will indicate that this would lead to a total cost of the bat *and* the ball of \$1.20, which contradicts the total cost indicated in the first line of the problem. If this error is caught before a final answer is given, the person can then think through some alternative responses, perhaps using trial-and-error, or working the answer out mathematically:

(Price of bat = x , Price of ball = y)

$x + y = 1.10$ (Equation A: *A bat and a ball cost \$1.10.*)

$x = y + 1$ (Equation B: *The bat costs \$1.00 more than the ball.*)

Replace x with $y + 1$ in equation (A): $(y + 1) + y = 1.10$

Therefore, $2y = 1.10 - 1 = 0.10$

So, y (price of ball) = $0.10/2 = 0.05$

Working the solution out in this manner takes longer than simply subtracting one figure from the other. However, whereas the simple subtraction that works under most circumstances fails here, the step-by-step approach reliably produces a correct answer.

There has been some debate about whether Type 1 and Type 2 thinking can be clearly distinguished; for example, it may be possible that specific thoughts may be described as both Type 1 and Type 2. Although cognition may be thought of as falling along a continuum between clearly Type 1 and clearly Type 2, complex cognition such as creative thinking will likely draw on processes from various points along the continuum. Type 1 and Type 2 thinking have often been referred to as System 1 and System 2, although such phrasing may potentially imply a structural distinction between the two that may not be borne out (at least not in the same way) at a neurophysiological level.

A related question in this area is how Type 1 and Type 2 thinking interact. A default-interventionist model would suggest that Type 1 thinking occurs first, and then may be revised by Type 2, which is more deliberative and therefore slower. In contrast, a parallel-competitive model of Type 1 and Type 2 processing would suggest they are occurring at the same time (Evans, 2007). Although a parallel-competitive model may not apply over a brief timeframe, it is likely that over the course of a longer creative endeavour, Type 1 and Type 2 thinking will occur to differing degrees, and so a parallel model may be applicable over a longer timeframe.

People can be encouraged to use Type 1 or Type 2 thinking to a lesser or greater extent, and then their performance can be compared on creativity tests (see Testing Creativity). Future research may benefit from experimental methods contrasting the two forms of thinking used in the thinking and reasoning literature. These include belief-bias syllogisms, in which researchers vary the logical validity of a syllogism and the believability of the syllogism's premises and/or conclusion. For example, the following syllogism is both logically valid and believable, so should not induce any conflict between Type 1 and 2 thinking:

All dogs are mammals
All mammals are animals
Therefore, all dogs are animals

In contrast, the following is also logically valid, but is lacking in believability, and so should induce a conflict between Type 1 thinking, which would favour believability, and so reject the syllogism as invalid, and Type 2 thinking, which would make it possible to ascertain that the syllogism is valid according to the principles of logic:

All teachers are musicians
All musicians are rich
Therefore, all teachers are rich

Factors such as pressing time limits may make people more likely to rely more heavily on Type 1 thinking. Tasks such as belief-bias syllogisms allow for a direct contrast between logical thinking and less deliberative thinking. This direct contrast can be difficult to capture in open-ended creativity tasks, where even if there is a conflict between Type 1 and Type 2 thinking it may be less clear whether there is a "right" response.

Dual Processes in Creative Cognition: Theory and Research

Folk psychological ideas around creativity, particularly as it relates to genius or ground-breaking innovation, may tend to overestimate the role of Type 1 thinking in creative cognition. Anecdotal evidence abounds about artists who cannot articulate how they came up with a particular idea, or other people involved in creative endeavour who have ideas that come to them "without having to think about it". Some theorists in the area of dual processes have described creativity as a Type 1 aspect of cognition (e.g. Sloman, 1996). However, those studying dual processes in creativity have been increasingly emphasising the role of both types of thinking in creative cognition.

It has been suggested that shifting between Type 1 and Type 2 thinking is important for creative cognition. For example, one idea may rapidly provoke a series of related ideas, but there is generally an iterative process whereby one must shift to Type 2 thinking to compare ideas that "spring" to mind with other ideas in long-term memory. Such an account would be consistent with a default-interventionist model of Type 1 and Type 2 thinking interaction, at least in the short run. At a neurophysiological level, it has been proposed that anterior cingulate cortex activity may act as a neurobiological marker of shifting between generative and evaluative modes of thought (Sowden et al., 2015). This is suggestive of an executive control process in shifting between the two types of thinking; it should be noted that this process in itself may require working memory capacity that is required for Type 2 thinking. Consequently, the delay between a response solely based on Type 1 thinking and a response also based on Type 2 will include the time taken to shift between types of thinking, as well as the time it takes to produce a Type 2 response.

Stage models of creativity (e.g. Wallas, 1926) have proposed a number of different stages in the creative process. Posited stages include problem finding and conceptualisation (where a problem/idea for a creative work is identified, and possible strategies for creative work are identified), incubation (where one stops thinking of the creative task for some time), illumination (where a novel idea forms), verification (where the creative work is checked for quality) and dissemination (where the idea is presented to others). A stage model has been used to elucidate the role of Type 1 and Type 2 thinking at different points in the creative process (e.g. Allen and Thomas, 2011). Allen and Thomas suggested that both Type 1 and Type 2 thinking may underlie creative cognition at all of these stages, with the possible exception of incubation (where an idea is left aside for a period of time, often when someone has reached an impasse), where sufficient Type 2 thinking may remove this stage. Shifting between Type 1 and Type 2 thinking may be employed at any stage of the creative process, and may enhance creative performance.

Illumination/insight has been a stage in the creative process that has been particularly subject to research interest with regard to dual processes in creative thinking. Insight problems have been frequently used in research examining creative thinking and problem solving; these are problems for which people can create different problem representations, and are often likely to create an initial representation which is not conducive to finding a satisfying response. Indeed, many such insight problems are deliberately phrased in such a manner as to encourage the typical person to create a conceptualisation that will frustrate their efforts to solve the problem. In such cases, a person is likely to reach an impasse. For example, the question “Two children are born on the same day to the same parents but they are not twins. How can this be?” is phrased in such a manner as to make the listener believe that the two children must by definition be twins, even though this is explicitly denied within the question. This impasse may lead people to return to the problem conceptualisation stage, where they may find a re-conceptualisation that allows them to solve the problem (in the example, they may think more broadly of the children as being born in a “multiple birth”, which in turn could lead to a solution; that they are two in a set of triplets). The often reported phenomenological “aha!” moment in creative problem-solving is a likely inspiration for the hypothesis that Type 1 thinking is key to this stage of the creative process.

Despite this “common sense” view that the “aha!” insight is due to Type 1 thinking, an interesting study contrasted thinking aloud about insight problems with articulatory suppression (i.e. repeating irrelevant information aloud); the latter would use up working memory processes that could have been devoted to the insight task (Ball and Stevens, 2009). The insight problems were remote associates tests (i.e. people were presented with three words, such as “cottage, cake, Swiss” and asked to find a fourth word, such as “cheese”, that could be combined with any of the other three words to form a compound word/phrase). For difficult insight problems, they found that articulatory suppression reduced performance, suggesting that at least for more challenging tasks, Type 2 thinking is important for insight; likely “kicking in” when Type 1 thinking does not swiftly arrive at an answer as it does for the simpler problems. Case study work on highly creative individuals has suggested that insights for such individuals can be protracted; the creative projects undertaken by such individuals involve great challenge and last a long time (e.g. Gruber and Wallace, 1999; see also Evolving Systems Approach).

Type 2 thinking is perhaps particularly important for verification, where initial drafts/sketches etc. of a creative work are examined for flaws and potential for improvement. For longer creative works, such as screenplays or novels, there may be a great deal of material to sift through for factors such as continuity of plot and consistency of characters’ behaviour. A lot of such work may be outsourced to editors; nonetheless, the cognitive processes involved in creating the finished product can be quite deliberative and step-by-step.

Stage theories have been useful in parsing the role of dual processes in creative thinking, but to better understand the cognitive style of creative people, one may take the approach of focusing on individual differences in Type 1 thinking and Type 2 thinking, and how they relate to creative performance. In an interesting study, individuals who were more prone to engaging in Type 2 processing made more creative connections on a remote associates test; however, they did not generate more ideas, or more original ideas, for an alternate uses task (Barr et al., 2015). These findings suggest that Type 2 thinking may be particularly useful for identifying links between apparently disparate concepts. More broadly, these results are a reminder of the diversity of methods used to assess creative cognition. Barr et al. distinguished between cognitive style and cognitive ability; it should be borne in mind that “failure” to use Type 2 thinking in a task could be a matter of a lack of motivation to use Type 2, rather than weak ability for this type of thinking. Nonetheless, a greater need for cognition in life in general is likely to be associated with greater creative achievement, as such individuals are likely to complete the creative process and see such projects out to the final stages of verification and dissemination of their creative work.

With increasing expertise, thinking processes that may have previously involved a great degree of Type 2 thinking are likely to become more dependent on Type 1 thinking, as they increase in automaticity. Experts with highly developed mental models of their creative field (and consequently a more detailed problem conceptualisation at the early stages of the creative process) may thus identify a novel conceptualisation without having to conduct as much research as a relative novice in the field. This could lead to insight at a more rapid pace, and a scan of the early drafts of an idea can be conducted more swiftly as the creative product is evaluated in more developed “chunks”. The stages of the creative process are therefore likely to differ in how types of thinking are employed with experts.

Applications

A provocative study looked at the generation of ideas for a store to attract more student customers (Dane et al., 2011). The best ideas were implemented by the store itself. It was found that those participants who reported a greater tendency to engage in Type 2 thinking performed better when they were assigned an experimental condition where they were instructed to draw on Type 1 thinking, and those who reported *less* of a tendency to use Type 2 thinking did better when instructed to use Type 2 thinking. This finding is suggestive of an interaction between the two types of thinking in innovative idea generation, and consistent with the hypothesis that switching between types of thinking is conducive to creative cognition. Dane et al. suggested that the use of a non-typical type of thinking may help to “break set”, as well as the possibility that a person encouraged to use a non-typical type of thinking may be more likely to use both Type 1 and Type 2 thinking.

Across various domains of creative endeavour, it is likely that drawing on both Type 1 and Type 2 thinking at various stages of the creative process can lead to better developed ideas. A greater awareness of a person’s tendency to engage in Type 1 or Type 2 thinking will be useful in allowing them to switch to a different type of thinking more frequently. Where there is conflict between the

suggestions of Type 1 and Type 2, it is likely that Type 2 processes will be used in evaluation, which may lead to bias towards the suggestions of Type 2. However, ideas drawn from intuitive, difficult to articulate processes may have great power in artistic domains; where there is an impasse about which output to choose, it is best to seek feedback from an impartial advisor.

Future Directions

Attempts to determine whether default-interventionist or parallel-competitive models of dual processes are more applicable in creative thinking may not be productive, at least with an either/or understanding, as these models may apply to a greater or lesser extent depending upon the timeframe over which creative cognition is studied. It may be more pragmatic to determine when and how individuals may switch between Type 1 and Type 2 thinking in creative work, and whether there are ways for people to recognise (and be taught how to recognise) when this is most of use. There has been some interesting work on training the use of “ideation-evaluation” within a stage theory framework (Basadur et al., 1982); Basadur et al. proposed that ideation is a divergent aspect of creative cognition whereas evaluation is convergent. Nonetheless, there is still a relative paucity of applied research investigating interventions that encourage switching between the two types of thinking in creative performance; there is thus still scope for much future research in this area.

Previous research has examined individual differences in the tendency to engage in Type 1 and/or Type 2 thinking; individual differences in tendency or ability to switch between the two types of thinking may be informative. Such switching may also be associated with creative achievement, although creative achievement may be associated with a number of factors beyond the person’s creative cognition, such as their ability to participate in different domains of creativity and their associated fields. Caution is required to avoid relying too heavily on verbal reports within this area, whether these are based on diaries of exceptionally creative individuals or self-report in a group of research participants. By their nature, Type 1 thinking processes can be more difficult to articulate. In particular, it may be difficult for people to retrospectively introspect on their frequency of switching between Type 1 and Type 2 thinking. It will likely be more fruitful to assess these processes during the creative process, using a think-aloud protocol or experience sampling method, or if possible actively encouraging the person to switch more or less frequently.

Notwithstanding the challenges around self-report, the increased tendency of creative individuals to document their work in online material such as blogs is generating a wealth of material for potential future case studies of highly creative individuals. However, considerable time may elapse between the production of reports detailing the creative process and the recognition of the ultimate creative product as a paradigm shift; one should not overestimate the likely longevity of online material, at least without the maintenance of effort to preserve such material.

Artificial intelligence approaches may help to explicate the role of dual processes in creative cognition. Whereas serial symbolic processing in AI has step-by-step, algorithmic information processing explicitly programmed in, connectionist approaches may capture parallel processing in a manner that is comparable to Type 1 processes that are unavailable to conscious introspection or verbal report. Hybrid AI may help to understand how the interaction between these types of AI can produce novel outputs. Such AI approaches may not only inspire models of human cognition, but also act as a tool for generating creative output.

Brain imaging technologies with high levels of temporal specificity have been of use in evaluating the role of pre-conscious or faster cognitive processes in creative insight. Such findings can shed light on Type 1 processes in creative cognition. With regard to linking brain regions to creative cognition, given the complexity of creative cognition, brain imaging techniques should focus on broader networks of brain activity rather than specific anatomical regions alone (see Neuroscience: fMRI). The default network is one such network, involved in daydreaming, as well as autobiographical memory and episodic thoughts about the future. Another network of interest is the control network, involved in executive function and working memory. The integration of function between the default and control networks may be important in explaining creative cognition (Beaty et al., 2014), and is a likely candidate for explaining how switching between Type 1 and Type 2 thinking is instantiated at a neural level (see Neuroscience: Default Network).

As noted above, Type 1 and Type 2 thinking occur on a continuum, and models of creative thinking within a given creative domain can further articulate underlying aspects of cognition from unconscious to heuristic to algorithmic. A fully developed cognitive science of creativity should account for how aspects of cognition such as categorisation, memory, attention and decision-making feed into creative cognition. To take the example of memory, understanding the dual processes involved in turning an episodic autobiographical memory into a short story would involve understanding how the memory “appearing unbidden” in conscious awareness is gradually tweaked into a fictional story that no longer recognisably resembles the memory of the experience.

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Dynamic Creative Process

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Dynamics and the Creativity Process

According to a dictionary definition, *dynamics* can be intended as “A pattern or process of change, growth, or activity.” Adopting a dynamic perspective on the creativity construct is therefore corresponding to the conceptual operation of placing the largest emphasis of the discourse in all those aspects which are subject to change with time, in combination with the variables of space, individuals, environments, and culture. Following the classic 4Ps terminology introduced by Rhodes (1961), this corresponds to giving highest priority to the analysis of the creative *process*, considering a flow of activities and conditions, such that the creative person, product, and press are all seen under a time-dependent point of view: the person’s creative potential and creative achievements in their developmental, operational, and life-time aspects; the product in its position inside an evolution of the culture pertaining to a knowledge and/or material domain, as well as cross-domain; the press as a sociocultural force determining variable success of a process, a person, and/or a product, within a culture or across cultures. The fact that a dynamic perspective shifts the focus of interest onto the process is also in agreement with the ideas expressed by Runco (2019). Conversely, a static perspective on the creativity construct considers achievement and recognition of creativity at a prime, giving priority to the creative product, and reading the person mainly as the author of creative products and actions, the process as leading to creative outcomes, the press as a facilitator or inhibitor of the success of a product at a certain time epoch. Clearly, creative achievement is the goal of a creative activity and its importance cannot be overestimated; at the same time, it is important to clarify the distinction between these two approaches, and in doing so, one discovers the importance of those periods of time in which the creative process is not met with any form of success. From a philosophical point of view, the static versus dynamic duality of perspectives could perhaps be traced back to the classic dichotomy between rationalism and pragmatism (Shalin, 1986), the terms of which are well explained by William James: “For rationalism reality is ready-made and complete from all eternity, while for pragmatism it is still in the making” (James, [1907] 1955:167). In other words, taking on a dynamic perspective on creativity studies can be seen as the adoption of a pragmatist, rather than rationalist, point of view on the subject, placing one’s concern on development more than existence, on trajectories more than equilibrium points, on estimation more than judgment, on processes more than products.

The Dynamic Definition of Creativity

In order to introduce a dynamic perspective on creativity studies from their foundation, it is necessary to adopt a definition of the creativity construct that is in line with the premises of pragmatism. As well known, the debate on the definition of creativity has been and continues to be a long one, being essentially concentrated on the search for the optimal number of criteria to be included in the definition itself, as well as their nature. As we discuss shortly hereafter, the number of criteria is actually not the main concern when we are interested in introducing a dynamic perspective. Given this consideration, the so-called standard definition of creativity (Runco and Jaeger, 2012), specifying two criteria for the existence of creativity, can be taken as a valid starting point for our discussion. This definition posits that *creativity requires both originality and effectiveness*. It is evident that this standard definition requires the presence of an observer and the recognition by this person of some form of originality (subsuming novelty, surprise, and authenticity) and effectiveness (which is domain specific) in what is observed. In doing so, this definition points to the recognition of an instance of creative achievement at a certain time and place, and in this sense, it should be considered to be static, i.e., concerned with a snapshot of creative success. Depending on the level of the achievement under consideration, this recognition could be personal, professional, or even disruptive for an entire domain of knowledge, thus becoming an important part of the cultural

evolution of the human species. However, this definition is not sufficient to cover the entire phenomenology of the creativity construct under a dynamic perspective, for the following two main reasons.

First, when a person, a group of persons, or even a society engages in a creative process, there may be a long period of time during which no outcomes are produced, no problems are solved, no effective ideas are generated, no innovative products emerge, with all trials appearing to fail notwithstanding the efforts and the resources that are poured into the creative endeavor. This means that the creative process in general includes possibly long periods of time in which originality and/or effectiveness (or whatever other criteria one should desire to adopt) are not recognized by anyone: these phases are actually of critical importance under the dynamic perspective, and as such they *must* be included in the definition of creativity.

Second, whenever out of a creative process explicit outcomes should appear, under the pragmatist perspective no single person is entitled to pronounce a definitive judgment on their originality and/or effectiveness: the best one can do is express a subjective assessment, an estimation of the values connected to the appearance of this product, which can always be the subject of a debate. The pragmatist maxim by Peirce applies here: “Consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of those effects is the whole of our conception of the object” (Peirce, 1992-1999, p.132). When an original object appears in front of us for the first time, our conception of this object requires an exercise of imagination of all of its possible effects which might have practical bearing on possible future realities: no one can close such an immensely vast and open-ended exercise, irrespective of one’s level of expertise in any knowledge domain. It is also quite possible that experts’ opinions will diverge, once this freedom is actually taken advantage of. Indeed, the history of the arts, science, and technology has repeatedly shown that the higher the originality of an idea, the stronger the debate induced into the relevant field of experts, typically becoming fractioned into opposing fields of adopters versus opposers of the new paradigm. In essence, requiring absolute recognition of originality and effectiveness in order to allow the existence of creativity appears to be far too stringent a requirement.

For the two above reasons, in order to endorse a dynamic perspective on creativity studies and to cover the entire process including generation and estimation phases in all their possible articulations, it is appropriate to adopt the following dynamic definition of creativity (Corazza, 2016): *creativity requires potential originality and effectiveness*. Interestingly, the only difference between this definition and the standard one is the introduction of the concept of *potential* as a fundamental part of the creativity construct, and it is this single word that transforms the perspective from static to dynamic, creating the needed pragmatist space for development, change, uncertainty, and subjectivity. In the course of a dynamic creative process, the level of potential for originality and effectiveness could be high, moderate, or low depending on myriad variables. Then, at a certain time and in a given cultural space, the potential of an observable outcome could be recognized by someone, giving rise to an instance of *creative achievement*, or it could remain totally unrecognized, leaving the process into a state of what can be defined as *creative inconclusiveness* (a terminology that indicates that the creativity episode should not be considered to be concluded). In fact, creative inconclusiveness and creative achievement can be considered to be the black and white extremes of a scale of gray, and the creative process can be visualized as dynamically fluctuating on this scale, at any time instant being it possible to estimate its state as residing on a specific position on the inconclusiveness/achievement scale. Importantly, creative inconclusiveness can be visualized as the other side of creative achievement in the creativity coin, and as such it is fully part of the dynamic creative process, and indeed a crucial phase. The creativity construct cannot be studied by only looking at the positive events in which creativity is recognized, but it is necessary to add the understanding of the important implications associated to the absence of any recognition, either by oneself or by the outside observers, as experienced when the process visits a state of creative inconclusiveness.

States of Creative Inconclusiveness

States of creative inconclusiveness can indeed be recognized in all models of the creative process. For example, considering the classic four stages model by Wallas (1926), the stages of *preparation* and *incubation*, which can involve long time and large efforts, should certainly be classified as states of creative inconclusiveness, and yet they are certainly very important parts of the process. In fact, longer preparation times, which may include multiple definitions of a problem to be addressed, collection of information from multiple sources, inclusion of inspiration from other disciplines, and so on, can significantly increase the potential to produce ideas that will later be blessed by recognition of both originality and effectiveness. The following stage of incubation, in which very significantly no apparent effort is spent on the creative exercise, allows for neural work below the level of awareness, as beautifully described for example by Henri Poincaré (Corazza and Lubart, 2019). Even after *illumination*, the creative process might return to a state of inconclusiveness if the *verification* stage fails in satisfying the initial objectives. Sometimes, one may want to purposefully prolong this state of creative inconclusiveness to explicitly increase the chances for higher originality: in the terminology of creativity practice, this indication is typically given through the advice: “avoid early closure.” In other words, if a person is immediately satisfied by the first outcomes out of a creative process, his/her chances to achieve significant results are typically reduced, since the more original ideas are remote and require prolonged efforts and resisting any temptation to conclude the process due to failures or even small/partial success. Under this perspective, the ability to extend a state of creative inconclusiveness appears to have very important consequences in increasing one’s potential for originality and effectiveness. A paradigmatic example may be seen in the correspondence between Vincent van Gogh and his brother Theo, in which the painter describes his experience of repetitively scraping off initial figures and producing more and more refined versions of the initial idea. As Vincent himself declared (Brower, 1999, p. 686), this behavior was not caused by impatience (or by any form of psychopathology), but by the willingness and strong determination to improve, learn, and pursue perfection. As a consequence, creativity studies under the dynamic perspective can and

should concentrate efforts on the analysis of the characteristics that creative persons exhibit when experiencing states of creative inconclusiveness, finding a correct place within this theoretical framework for known concepts such as tolerance of ambiguity, persistence, resistance to frustration, and so on.

Estimation of Creative Achievement

As discussed above, in a dynamic creative process creative achievement cannot be established once and for all, but it can only be estimated from the point of view of those observers/estimators who are presented at a certain time with the creative outcome. Depending on the level of sophistication of the product to be estimated, especially in terms of its originality with respect to the state-of-the-art, it may be more or less possible to achieve consensus among a given set of estimators. In other words, creativity measurement techniques and experiments that are based on obtaining consensual assessment of creativity levels by a set of experts are certainly adequate for those tests or conditions under which the level of sophistication and associated originality of the products is low to moderate. On the other hand, the higher the level of refinement of an outcome, and the more disruptive its characteristics with respect to the status quo, the more one should study the level of agreement versus disagreement between the involved estimators, avoiding to force consensus and taking into careful consideration all of the different facets of their assessments, trying to understand where and why they differ, in such a way as to allow this plurality of diversified opinions to finally lead to a thorough understanding of the real value of the creative outcome. In a dynamic creative process, diversity of creativity estimation by different experts is richness, and as such it should be preserved and cultivated.

In addition, adopting a dynamic perspective on the estimation phase of a creative process opens a number of research questions, many of which are yet to be explored in full by the scientific community. The following can be considered to be a nonexhaustive list: a) given that the full engagement of an estimator with a creative product is actually a creative effort in itself (i.e., trying to imagine all possible uses of a new idea in all possible future scenarios), which methodologies could be introduced for studying creative performance as an instance of estimation of the outcomes of a creative process; b) how could this estimator's meta-creativity (creative estimation of other's creative products) be measured; as an example, through the number and diversification of the possible interpretations that an estimator is able to conceive of a creative item in a predetermined time interval; c) what could be the impact of embedded cognition on idea estimation, or in other words, how does the environment (including the relevant emotional climate) influence the performance of an estimator; it is in fact conceivable that assessment of an idea would change by modifying the environment (physical or virtual) in which the estimation phase takes place; d) how could the discrimination ability of original ideas be measured (e.g., through the diversification of the possible consequences derived within a set of expert/nonexpert estimators); e) how could historiometric studies be carried out in the realm of idea estimation, as materialized through the diversification in the estimates of originality and effectiveness of a creative outcome in the short, medium, and long term after its generation; f) how could cultural anthropology be applied to creativity estimation, to characterize the diversification in the estimates of originality and effectiveness of a product as a function of cultural differences of the estimators; g) what could be the effects of social competition on idea estimation (e.g., as measured through the correlation between the estimator's own ability and the assigned creativity scores); h) what could produce social bias effects on estimation, as identified, for example, in dynamic effects of knowledge about other estimators' opinions on a specific estimator's assessment of a product; and i) how could developmental and educational experiences in cultivating creativity in a classroom be characterized; what would change in terms of the overall educational effectiveness depending on the ability of an instructor to act as an estimator of the value of the creative outcomes produced by the students, as opposed to playing the role of a judge who assigns definitive scores.

Creative Potential

As well known, the notion of potential occupies an important place in creativity studies, irrespective of the adoption of either a static or a dynamic perspective. It is therefore necessary to clarify the role of this fundamental concept, once that it is introduced within the definition of creativity itself, as in the dynamic definition introduced above. First of all, considering this word from an etymological point of view, "potential" derives from the Latin adjective "potis," which can be given two different acceptations: capable or possible. Capabilities are first and foremost associated to individual characteristics, leading to the concept of individual creative potential. On the other hand, possibilities can naturally be mapped on characteristics of the state-of-the-art of the overall knowledge of the human species (given our state of cultural evolution, what are the next possible steps for the human kind), such that the potential for originality and effectiveness assumes broader and broader meanings by considering organizational, social, sociocultural, all the way to cosmological realms. Given that creativity studies can usefully follow several classification schemes, such as the already mentioned 4Ps by Rhodes (1961), the 5As classification by Glaveanu (2013) in terms of Actor, Action, Artifact, Audience, and Affordance, as well as the more recent 7Cs classification by Lubart (2017) in terms of Creator, Creating, Creature, Collaboration, Consumption, Context, Curricula, the question would be then: in what form does the concept of potential appear under each of these perspectives? Answering this question leads to a broadening of the analysis far beyond the classic study of an individual creative potential, introducing branches of research dedicated to the potential of a creative process under systemic or embedded perspectives, the potential of an affordance under a material perspective on creativity, the potential of an environment under a sociocultural perspective, and so on. In essence, within the dynamic theoretical framework for creativity the concept of potential is pervasive, and its study and characterization could be considered as a guiding light for researchers in the years to come.

Dynamic Phenomena and Methodologies

While the previous sections were dedicated to defining and setting up a theoretical framework for the study of the dynamic creative process, here we address a few specific topics which can now be seen under the light of this framework; in some cases, these topics could not altogether be conceived unless the dynamic creativity framework were adopted.

Trajectories in Educational Contexts

Beghetto and Karwowski (2019) consider the study of creativity in a classroom, explicitly trying to move away from classic static approaches based on standard tests, and introducing dynamic microlongitudinal designs to describe student–teacher interactions and the evolution of confidence beliefs. Their work is based on four assumptions, here slightly paraphrased using the terminology introduced above: a) Uncertainty acts as a catalyst of creative dynamics; b) Creative thought and action emerge from a dynamic process; c) Determinations about creative achievement are based on generally agreed criteria (e.g., originality and effectiveness); d) Estimation of creativity is dynamic and therefore subject to change across time and contexts. As can be immediately realized, these assumptions confirm that the work by Beghetto and Karwowski (2019) fits perfectly within the theoretical framework described above. Given these assumptions, the problem is how to characterize the dynamic creative process within a classroom environment, and the microlongitudinal approach is the methodology proposed by the authors. Essentially, this approach requires repeating measurements on the phenomena under study with a very high repetition rate (e.g., several times per minute), the results of which can then be analyzed either in a qualitative or in a quantitative way. As an example, trajectories of interaction between a teacher and his/her students can be visualized on a two-axes plane, with time in the abscissa and determination/indetermination of the utterance mapped on the ordinates: the resulting graph gives a unique and immediately understandable picture of what has been happening in the course of a creative session, showing how a conversation (perhaps initiated by the teacher) could start from large indetermination and then converge through a creative process to an agreed idea with a potential for originality and effectiveness. From a quantitative perspective, this microlongitudinal setting lends itself, for example, to a dynamic measure of creative confidence, taking relevant measurements before, during, and after the task. The analytical tools to be adopted are less oriented toward the extraction of inter-individual differences but rather of intraindividual differences, such as multilevel modeling and network modeling (Beghetto and Karwowski, 2019).

The Serial Order Effect

One of the most adopted methods for the measurement of the divergent thinking ability, an important component of an individual's creative potential, is undoubtedly the Alternative Uses Task (AUT), according to which the participants should come up with as many as possible unusual uses of a common object. AUT performance can be measured with several parameters, the most common of which are fluency (i.e., the number of responses produced in a fixed time interval) and response originality (as scored through frequency or by external estimators). This is a typical task in which the time dimension plays a crucial role: the process of generating alternatives changes drastically as time goes on and as responses are produced in series, hence the identification of this dynamic phenomenon as the serial order effect (Wang et al., 2017). Typically, in the first minute fluency is maximum but originality is low, as responses draw upon access to memory or alternatives which lie at a short semantic distance from the typical use of the object. As time goes on, fluency is reduced but the potential for originality of the responses grows dynamically, as the individual is forced to imagine uses that he/she has indeed never seen before. The serial order effect has neural correlates that are still being investigated; for example, Beaty and Silvia (2012) discuss how both default mode and executive control networks are involved in the AUT dynamic process, showing that intelligence comes in to moderate the serial order effect: as intelligence increases, the serial order effect diminishes. The investigation of how cognitive abilities are dynamically involved in the creative process is clearly a very fruitful avenue for continued research.

Dynamic Creativity Measurement Techniques

Carruthers and MacLean (2019) consider the implications of the adoption of the dynamic definition of creativity over the measurement techniques typically adopted in the field of creativity studies, with the aim to propose alternatives or modifications that could be capable to capture different nuances of the dynamic creative process. They consider several points and advocate diversified solutions, including: a) the importance of originality *estimation* (over fluency and frequency) in divergent thinking tasks, such as the AUT described above; b) the possibility (and opportunity) to extend Consensual Assessment Techniques to longitudinal studies, to see how consensus could evolve dynamically through time; and c) the opportunity to address not only creative achievement but also creative *inconclusiveness* instances with different self-reports, including the Creative Achievement Questionnaire (Carson et al., 2005), the Creative Behavior Inventory (Hocevar, 1979), or the Inventory of Creative Activities and Achievements (Diedrich et al., 2018), favoring those questionnaires that allow to describe activities with only a potential for originality and effectiveness but no apparent creative achievement.

Dynamics in the SocioCultural Manifesto for Creativity

Glaveanu et al. (2019) advocate that creativity researchers should endorse sociocultural perspectives in their studies, to complement and integrate the more investigated perspective of individual creators. Among the twelve principles discussed in Glaveanu et al. (2019), one is specifically devoted to the discussion of the dynamic framework, under the heading: "Creativity is dynamic in both its meaning and practice." In fact, the manifesto argues that both the understanding and the practice of creativity vary across space and time, and from this descends a difficulty (if not an impossibility) to operate with a reductionist definition of this phenomenon. Originality and effectiveness could be considered as cross-cultural markers of creative achievement, but even this static definition is the daughter of a historical time and geographical place (i.e., modern Western society). While we acknowledge that there is value in a static definition of creative achievement and its use in scientific investigations, at the same time we should always recognize that estimation of creativity is context-dependent, and we should explore not only what is or is not creative but also *why* we identify something or someone as creative (or not). As discussed before, the authors of the manifesto agree that a dynamic approach to creativity shifts the attention of researchers to the process underlying creative activity and to its potential to produce outcomes that impact possible futures.

The Dynamic Universal Creative Process

A final extension of the consequences of the adoption of a dynamic perspective is in order to conclude this entry. A static approach has the characteristic that, once the judgment on an outcome of a creative process has been given, that instance of the process could effectively be considered as ended. On the other hand, if the dynamic perspective is adopted, and specifically the fact that creativity involves a *potential* for originality and effectiveness, and that this potential evolves through time, it is correct to ask if it is possible to precisely delimit the start and the end of what we could identify as a *dynamic creativity episode*. Upon reflection, it becomes apparent that the dynamic creative process can neither have a clean slate start (we cannot create ex nihilo) nor a unique end, anywhere at anytime. In other words, it is always possible for a creativity episode and/or for its consequences to continue to evolve indefinitely in the future, as a minimum according to the following four mechanisms, as discussed in (Corazza, 2019). First is the mechanism of *continued exploration*, which corresponds to the case when the creative person (or persons) continues to invest resources in an episode irrespective of being in a state of creative inconclusiveness or creative achievement. No prefixed mandatory termination can be envisaged for this exploration phase, as the goals of a worthy creativity episode can be passed on from person to person, or even from generation to generation. Second, even in the presence of creative achievements by a person, the dynamic creative process can and will still continue, typically through the eyes of others: *creativity estimation*, which is an integral part of the process, can continue across time epochs, and ideas that once were not considered to be of any use, could in the future turn out to be of seminal value (or vice versa). The history of science and technology is ripe with instances of this kind, such as, for example, the drawing of a parachute by Leonardo da Vinci, four hundred years before it could actually be realized. Through this extended phase of creativity estimation, every creative episode has the potential to generate long waves of cultural evolution. Third, the outcomes of a creative episode might become the source of a subsequent creative activity. Indeed, the creativity episodes occurring across the cultural evolution of the human species could be shown to be either directly or indirectly *concatenated*: for any achievement of today, we could identify the elements introduced by previous generations that turn out to be the enablers for new progress. Fourth, we should recognize that the potential for originality and effectiveness of the product of a dynamic creative process is not limited by the goals that were initially intended by its creator. In the emerging dynamics, a product might acquire in the future a totally new functionality, and thus be transformed into a completely new creative achievement, which in some cases could be much more significant than the original one. In evolutionary biology, this functional transformation is identified as *exaptation* (Gould and Vrba, 1982), to indicate those new features of an organism that enhance its fitness, but that did not come through Darwinian adaptation.

The main consequence of this discussion is the following: accepting the proposition that the dynamic creative process cannot have an intrinsic predetermined closure, being extended indefinitely in the future through the mechanisms of continued exploration, creativity estimation, concatenation, and exaptation, all creativity episodes can be conceptually concatenated and concur to form an overall process that produces our cultural evolution, an integrated process which we can identify as the Dynamic Universal Creative Process, defined as follows: "The active ensemble of all creativity episodes in the course of cosmic evolution" (Corazza, 2019). This macroscopic view of the creativity phenomenon as a dynamic process appears to be in line with that proposed by Alfred North Whitehead, who in his manuscript entitled "Process and Reality" (1978/1929), discusses a cosmology in which creativity is the ultimate metaphysical principle (p.21): "Creativity is the universal of universals, characterizing ultimate matter of fact. It is the ultimate principle by which the many, which are the universe disjunctively, become the one actual occasion, which is the universe conjunctively. It lies in the nature of things that the many enter into complex unity."

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Further Reading

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Eccentricity[☆]

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Introduction

Few notions convey a depth of ambiguity equal to “eccentricity.” Its early use was as a scientific description of deviation in the elliptical motion of orbital objects (Merkin, 2014). However, it was co-opted to mean, at least at an inferential, surface level an identity guided by “peculiar” actions that deviate from convention (Gill, 2009). At a deeper level eccentric individuals are characterized as being both mentally ill and joyful; they are both cultural icons and transgressive outsiders; they are both objects of admiration and of pity.

There is, underneath all this contradiction, a deeper, more tangible character that eccentrics are individuals who live at the margins of society and “normal” social order (O’Connell, 2017). Eccentrics are therefore, by virtue of their “otherness,” not representative of norms in collective identity (Kroflic, 2007); they are not, in other words, “centric” to mundane values and banal courses of action in everyday society.

And yet, eccentrics persistently attract attention because of their uniqueness and the dynamic perspective this can lend to interpretations of their work: Great artists, poets, mathematicians, and scientists are known for their quirks and often discussed in terms of their bizarre and creative genius. Similarly people are perennially enticed and titillated by the uncanny, the exotic, and the transgressive, which individuals long to experience, if only from a safe distance (as in Stallybrass and White, 1986). In this way, there seems to be an elementary subject–object relationship to eccentricity as a human experience: Depending on the observer and the narrative of marginality to which they are susceptible, the quality of being eccentric is transformed.

Building from this definition of eccentricity, three deeply interrelated themes can be articulated: That (1) eccentrics are, in themselves, simply marginal individuals whose exploits are to be considered primarily on the basis of that condition, that (2) eccentrics are happy nonconformists who, by various means, choose to accept their outsider status in a positive way, and that (3) eccentrics are unhappy, tortured individuals whose social marginalization is a symptom of a chronic disease of the mind (Weeks and James, 1996). These themes are not mutually exclusive; they are interpretations situated in a particular social and historical context.

In the following sections, each of these themes will be explored with attention afforded to the manner in which the term “eccentric” is utilized by proponents and detractors, as well as the circumstances which may have promoted such an interpretation. The consequences of adopting the theme will be considered, as well, most especially concerning conceptualizations of the creative personality, as elements of nonconformity, strangeness, joyful weirdness, and madness may be indicators of an individual’s tendency toward eccentricity and creativity in equal measure (Weeks & James, 1996), and it seems undeniable that there is some shared relationship.

Eccentricity as Life in the Margins

Before eccentricity connoted either joy or insanity in the popular imagination, it was figuratively associated with a concern for social deviance (Merkin, 2014) and a highly specific, complex fascination with those persons who might constitute a “grotesque” or

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socially unclean station (Stallybrass and White, 1986, pp. 22–24). Thus, it should be no surprise that this use of the term has encompassed many socially marginal and stigmatized categories of individuals, including sexual minorities, racial minorities, and the disabled (O’Connell, 2017).

As Gill (2009) identified, it was this expansion of the concept of social deviance, rife with its implicit references to social station and a fear of “savage” minorities, that would later take root in broader Western culture. Among these were gender-bending aspects of the eccentric French “dandy,” which problematized notions of singularity, vanity, flamboyance, and aspirational fashion (2009, pp. 71–74), and the fraught character of the Parisian Bohemian, whereby authors and artists mediated (and, at times, celebrated) the seedy underworld of the “Paris inconnu” (2009, pp. 175–177). These depictions created a carnivalesque concept of marginal eccentricity perceived through the lens of the exterior tourist, the dilettante, or explorer—within reach of a middle class in pursuit of easy status and pleasure, and just as quickly divested.

There are suggestions, too, that such efforts at labeling underclass marginal individuals as “eccentrics” in this way had, at some psychological level, a secondary purpose: an effort on behalf of the social majority to “tame” unruly outsiders by rendering them familiar and, therefore, harmless. As Kroflic (2007) pointed out, the once-salient archetype of the Court Fool, drawn from medieval European observations of foreigners and the mentally ill, had largely, by the modern era, been relegated to the considerably smaller “roles of the local eccentric and the clown, who are allowed to speak about the unspeakable truths of existence at the price of exclusion from normalized society” (p. 37). Perhaps capturing the ethos of this position more directly, the critic Mark Storey complained that the work of the highly nonconformist novelist and poet Stevie Smith would suffer from her being labeled “eccentric” as, in his estimation, “Eccentrics are not dangerous. [...] Their value fades in their passing” (Blumel, 1998, pg. 112).

O’Connell (2017) argued that the ambivalent attitude toward social marginality and eccentricity—individuals being different enough to merit some concern but safe enough to avoid serious censure or legal penalty—has noteworthy consequences in our modern world. Increasingly, the understanding of disability, discrimination, and the value of diversity are calling to question the concept of “normalcy” as the (de facto) default condition of identity (O’Connell, 2017, pg. 353). This is, in part, due to social and biomedical advancements that have occurred in recent decades, whereby more accurate diagnosis and incremental destigmatization of mental illness have led to unusual, odd, or marginal behavior being classified as relatively minor and benign expressions of disability (2017, pg. 255). As a corollary, eccentricity has become a salient topic in critical postmodernist arguments against the historically binary categorization of “disability” and “normality,” most especially as highly variant—and therefore seemingly strange—self-expression is often bound up in the efforts of social minorities from all walks of life to make meaning from their experiences (2017, pg. 355–356).

This is perhaps no more clearly seen than in creative works that constitute the notion of “outsider art.” Here, the genre classification fundamentally depends on the background and experiential viewpoint of certain artists who are, in this case, “people with no formal artistic training, who are isolated from the dominant culture and the mainstream art world, and who create art that is idiosyncratic or without precedent” (Wojcik, 2008, pg. 179). A common link found among outsider artists is that they most often find themselves drawn to creative action as a means of coping with various forms of adversity, as, for example, Chester Cornett did as a response to his challenges dealing with his children’s disabilities, the consequences to his employment prospects and the stability of his marriage, and his own feelings of isolation and paranoia (Wojcik, 2008, pg. 187). In this way, creativity can be seen as a therapeutic balm to traumatized individuals who might also be suffering from marginality and, for some, mental illness (2008, pg. 194).

What, if anything, is the value of this thematic perspective of the marginal eccentric? Possibly, it is in its ability to convey a sense of the basic, unadorned humanity at the core of eccentricity. We are, all of us, potentially the outsider to some group of people. Marginality is highly contextual, and so “eccentricity” is an identity status that can apply to anyone. And yet, it is seldom willingly adopted by outsiders, being instead more often determined by others. In this way, eccentricity can be seen to indicate a stereotypical social role that has become more common, and therefore more recognizable, in the wake of technological and cultural advancements that put people into contact with a greater diversity of people. But this use of the term, with its history as a euphemism, is not wholly neutral: It conveys a sense of the imbalances of power experienced by marginal groups and the reciprocal relationship of subjugation and fascination that accompany such interactions.

Eccentricity as Happy Nonconformity

It has been historically demonstrated that certain individuals undertake to choose a life of eccentricity, warts and all, as a means of successful self-expression and thereby find themselves happier for the decision. This is a perspective on “eccentricity” as understood, for example, in the writings of Dame Edith Sitwell (1957), who, in her landmark compilation, detailed the lives of several dozen British eccentrics. Nearly everyone of these individuals were eminent—that is to say, famous, noteworthy, and highly respected—personages engaged in high positions in the military, medicine, writing, or aristocratic society. Here, Sitwell might well have been making for herself a host of good company, as she was considered to be a notorious eccentric with similar characteristics to the people in her book (Weeks and James, 1996).

Sitwell’s view of happy nonconformity is one which also has since emerged in the study of eccentricity as a topic of direct systematic review. In their (1996) book, Weeks and James detailed their investigation of the traits of some 789 self-identified eccentrics utilizing qualitative and quantitative methods as varied as informal conversations, structured interviews, and psychometric

inventories. [Weeks and James \(1996\)](#) found a convergent set of 25 characteristics shared by the greatest number of participants in their study, some of which included:

- Enduring nonconformity
- An enduring and distinct feeling of differentness from others
- Creative
- Strongly motivated by exceedingly powerful curiosity and related intellectual exploratory behavior
- Idealism, wanting to make the world a better place and the people in it happier
- Happily obsessed with a number of long-lasting occupations
- Intelligent
- Opinionated and outspoken, convinced that they are right and the rest of the world is out of step with their ideas
- Noncompetitive
- Not necessarily in need of reassurance or reinforcement from the rest of society

Of these, the first five characteristics were considered both the most valuable and the most widely represented, though Weeks' unofficial addendum to the list was that eccentrics are "happier than that rest of us" (1996, pg. 27). Nevertheless, the primary identifying feature of eccentricity was noted to be a tendency toward nonconformity ([Weeks and James, 1996](#), pp. 27–28). Here then, we see evidence of an implicit, but highly significant, reciprocal relationship in this construction of "eccentricity": That there is a condition of nonconformity that essentially depends on the happiness and success that it entails, as well as the joy and positive creative self-expression it promotes, as the basis for understanding the identity. As such, one cannot understand [Weeks and James \(1996\)](#) characterization analytically as being a sum of these qualities and the positive affective states they evoke, but instead must think of eccentricity as a transcendent virtue of the traits in combination.

However, central as it is to this notion of eccentricity, nonconformity in itself poses something of an intractable problem for maintaining a socially neutral framework for the construct, especially as it relates to status. As [Ridgeway \(1981\)](#) posited, the desire for nonconformity bears considerations of social status, perceived competence, and motivation. Thus, it is generally thought to be desirable to enact nonconformity in ways that confer status, and it is undesirable to fail to conform in ways that might impose stigma. As [Sitwell \(1957\)](#) indicated, a corollary of this perspective is that high-status, eminent individuals are seen to be happy nonconformists because implicit and explicit attributions are made to the unique, individualistic (and, therefore, nonconformist) characteristics of an eminent person. But, as [Marcus \(1995\)](#) identified, it is likely that the relationship is more complex and textured, with eminence, and not nonconformity, possibly guiding the narrative—or, as he has stated:

From the perspective of the social judgment and attribution of eccentricity to particular persons, especially of great wealth, power, or celebrity, eccentricity is often associated with the distortion effect or excess associated with the bearing of great wealth or exercising of great power. That is, merely bearing great wealth or exercising great power is quite exotic in the imaginations of most people ([Marcus, 1995](#), pg. 48).

But, at the same time, the value of nonconformity has also been linked with positive personal qualities which comprise universal elements of intelligence and creativity: [Dollinger et al. \(2002\)](#), for example, have cultivated insights of this type by means of a small series of studies that assessed 591 participants in terms of their tendency toward individuality, their willingness to engage in intellectual pursuits, their openness to experience, their need for cognition, and their curiosity. In service of this effort, the authors utilized a mixed-methods design, incorporating diverse indicators of personality, including photo essays, self-report academic disposition surveys, and psychometric scales. Their findings supported "the general proposition that individualistic persons provide evidence of an inquiring intellect much more than their conventional peers," and further contributed to the suggestion that "as a kind of self-applied creativity, individuality seems to begin in ideas about who one might become" ([Dollinger et al., 2002](#), pg. 223).

More broadly, it is a distinct celebration of the individualistic, creative, and successful person which, to some extent, drives the shared comprehension of "stereotypical"—if that word can even apply here—"creative geniuses" and, by consequence, the creativity attributed to their works. [Van Tilburg and Igou \(2014\)](#) compared the perceived eccentricity of an artist and the tendency of everyday individuals to assign creative value to their products. [Van Tilburg and Igou \(2014\)](#), in a variety of settings, identified a "stereotype confirmation" effect by which creativity and eccentricity are related via shared associations in the stereotype. For instance, in one study where participants were randomly selected to learn of Van Gogh's bizarre actions, including severing his ear, they evaluated his art as being more creative than participants who did not receive the stereotype stimulus. Across five such studies, the researchers came to the conclusion that "creative endeavors are clearly not solely determined by the quality of the creative outcomes but also depend crucially on the perceived degree of eccentricity of the artist—a characteristic that is peripheral to the artwork but nonetheless impactful for its evaluation" ([Van Tilburg and Igou, 2014](#), pg. 103).

This raises an important question: If the theme of marginality conveys humanity, what is to be learned from the perspective which treats eccentricity in such a celebratory manner? Perhaps it is that eccentricity, for some, represents their aspirations for success and social regard. In this view, the eccentric person is valued and respected for their contribution to society but also free enough that, should they choose, they might wear clothing made entirely of meat. Clearly, too, there is some common tendency among the notions of eccentricity, nonconformity, and individuality which are associated with the psychological freedom experienced by

artists and writers. That this seems to include qualities of creative individuals as perceived in society is a powerful insight: Are creative works that are carried out by mundane people somehow worse than those carried out by bizarre eccentrics? Is there a quality to eccentricity that enlivens even work lacking in technical execution, making eccentricity its own cause for creativity? Is there a psychological tendency to impose characteristics of eccentricity into the personal narratives of eminent artists even where none exists?

Eccentricity as Mental Illness

There is no denying that “eccentricity” denotes mental illness. [Tantam \(1988\)](#) traced the likely origin of this use of the term in an effort to categorize mental illness in the dawning days of what would eventually become abnormal psychology. Thus, it was from Kraepelin, the founding father of psychiatry, that eccentricity implied something in the nature of “dementia praecox” and from Bleuler, who coined the terms “schizophrenia” and “schizoid,” that eccentricity was first associated with his early conceptualization of “autism.” And, to be clear, these are not attributions that have faded, in any way, over time: A quick review of the Diagnostic and Statistical Manual revision 5 (DSM-V: APA, 2012) reveals, among the modern diagnostic criteria for the “Cluster A Personality Disorders,” inclusive of paranoid, schizoid, and schizotypal personality disorders, the traits “Odd, bizarre, and eccentric.”

As such, one necessary step in justifying eccentricity from the position of happy nonconformity, as above, has often been to distance the term from these clinical usages. And, for their part, [Weeks and James \(1996\)](#) did an admirable job, as they organized their study, of disentangling the two perspectives by means of empirical assessment. That is to say, among a subset of their participants, that [Weeks and James \(1996\)](#) recruited 130 self-identified eccentrics who agreed to take the Present State Examination, an interview procedure by which they would be able to assess certain mental disorders. They reported that only 8% of their participants displayed even mild symptoms of any of the Cluster A personality disorders—higher than the population at large, but by no means an all-inclusive characteristic of eccentrics in their study. Further, the authors distinguished the mental capacities of their participants, most especially those related to the productive generation of mental imagery, from those of individuals with schizophrenia:

One common trait of eccentrics is that they often experience mental images that are more vivid than those of normal people. Some extreme eccentrics have visions, which is a not uncommon symptom of schizophrenia. The important distinction is that the schizophrenic has no control over his visions and the voices he hears; they intrude themselves upon him forcibly and give rise to a terrifying sensation of powerlessness. The eccentric, on the other hand, is likely to find his visions a source of delight, and he has much more control over them. The psychotic state severely disrupts thought processes, leaving the person dysfunctional, whereas the eccentric’s brain usually functions perfectly well – it just does so in peculiar and largely unknown (and unknowable) ways.

Apart from efforts to differentiate what is essentially “good,” or functional, eccentricity from “bad,” nonfunctional or maladaptive, eccentricity, there are attempts to understand the condition of eccentricity itself from the position of how it is understood by individuals with mental disorders. To this end, [Ellerby \(2015\)](#) reflected on his own experiences as an eccentric in light of receiving a diagnosis of schizophrenia at age 22. His perspective was that his “madness,” whatever that might entail in his life, could only be “trivialized” by being labeled an eccentric:

Eccentricity may be a characteristic displayed by some mental patients, but being eccentric itself is a behavior choice. If we look at the mad hatter’s condition [for example] under a modern day perspective, it is clear that he had not much choice in acting the way that he did; he was truly sick. Calling him eccentric diminishes his true issues. That is where trivialization becomes a problem

Ellerby (2018, pg. 466)

Likewise, there have been efforts to determine what, if anything, the status of being labeled an eccentric might contribute to the long-term health of individuals with chronic mental illness. [Tantam’s \(1988\)](#) interviews with 60 psychiatric patients identified a relationship between odd or “eccentric” behavior and lifelong isolation. Tantam found uniform antisocial interpersonal behaviors, including a propensity toward violent crime, as he came to describe his participants unanimously as being “profoundly socially handicapped” (1988, pg. 777). Here, the value of Tantam’s research is not found in the direction of the proposed correlation between identifiers of eccentric isolation and social perturbation—which is entirely expected—but instead in the magnitude of the effect: It is disheartening and sobering to learn that, for instance, the majority of eccentric participants in his study were unable to live alone, and that many of them assaulted members of their own families (1988, pg. 782). Furthermore, these findings frame conditions under which eccentricity might not be seen merely as a trivial condition referent to chronic mental illness.

And what does this understanding of eccentric mental illness say about creativity? It has been proposed that the triune relationship among creativity, eccentricity, and mental illness or “madness” may be one of balanced contrasts. In line with this thinking, [Prentky \(2001\)](#) proposed that creativity might entail the “optimal degree of deviation from normal patterns of information processing,” by which we might conceptualize both eccentricity and mental illness to be more distant deviations from the optimally creative margin. The question here is one of the valid linearity in the underlying continuum: Is there indeed a single, linear system of quantities undergirding a person’s divergence in thought, by which “enough” might be thought to be “creative” and “eccentric” according to positive connotations, but “too much” could reasonably be classified “mentally ill”? [Schlesinger \(2009\)](#) did not appear

to think so. She argued that this type of linear relationship in creative extremes is untenable, being based on poor science which has only confirmed a distorted view of creativity according to a cultural stereotype of the “mad genius.” Further, she put forth the position that an individual’s identification according to the stereotype does not represent an alignment of values, but signifies instead efforts on behalf of creative individuals to psychologically protect themselves by providing a “semblance of consistent identity in a life full of occupational stops and starts.”

In the end, it may be the case that understanding eccentric mental illness, as in the other two thematic interpretations of eccentricity, is based on a social value assigned nonconformist behavior. Here, it is perhaps a feeling of fear that historically contributed most to the notion of eccentric mental illness. Oddness in behavior can sometimes be challenging, intrusive, irritating, and scary. It betrays hints of exotic, or possibly egocentric, thinking that can be taken to mean that an individual does not or cannot engage in social discourse in a eusocial manner. Upon experiencing the notable break of an unspoken norm in an eccentric social interaction, reactive fear might well occur in the wake of an individual’s or social group’s lack of capacity to predict what the eccentric individual is capable of doing. In this way, antisocial eccentricity might be viewed as an essential corollary to the behaviors associated with schizoid personality disorders—these being partially communicated by the extremity of their negative impact on an individual’s orientation to social settings. And while it may, at first, seem completely tangential, the topic of creativity here has a particular bearing: For, if unusual thoughts drive unusual behavior, eccentricity becomes a universal indicator potentially signifying both. It may be only through later analysis and interpretation that these experiences make sense because the original intent is uncertain.

Conclusion

All told, what does the effort of tracing a complex, tripartite conceptualization of eccentricity reveal? What, more directly, is the benefit to be gained from expanding understanding of eccentricity beyond Gill’s (2009) description of behavior that is “strange,” “peculiar,” or “odd”? Perhaps, it is in the effort of thoughtful engagement itself: Problematizing the notion of eccentricity invigorates discourse, accumulating layers of additional significance that allow new vantages on old concepts. Alternatively, the benefit of this sort of effort might be in the ability to better humanize eccentric individuals: Internalizing that marginality interrelates with both happy nonconformity and maladaptive behavior affords the capacity to contextualize eccentric individuals in a larger structure of the many, sometimes contradictory, needs and unspoken desires of society. And, finally, it may be that better apprehending eccentricity is a necessary step in grasping the origins of individualistic creative behavior, for, as this article illustrated, in every condition—among the richest and happiest and poorest in misery—persons who take up the banner of eccentricity express themselves in thoughtful, authentic manners that are, at once, somehow more heartfelt and more significant.

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Economic Perspectives on Creativity[☆]

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In 1994, paintings more than 30,000 years old were discovered in a cave in south-eastern France. Although it may be an early example of art or visual communication, humans did not live very differently at that time from other non-human animals. They lived off what nature had to offer even if evolution endowed the human species with creative potential. However, this way of life, regulated by the rhythm of nature, changed dramatically over the millennia; the invention of agriculture and livestock in the Neolithic era signals the first major economic consequences of creativity, defined as the ability to make productions that are novel and relevant. Human beings became not only consumers of natural resources but also producers, creating, depending on the abundance of crops and livestock, a tradeable potential surplus. This cognitive prowess may seem insignificant to us today because it consisted largely of recreating what nature knew how to create (although cross-breeding animals and plants was a creative act as well as tool making). The accumulation of knowledge necessary for the production of new resources required observation, imagination and testing of different possibilities that only a creative mind could accomplish; these inventions had such economic and social consequences that historians speak of a Neolithic Revolution. From nomadic hunter-gatherers, in a few millennia, people became sedentary farmers on all five continents (see Barker, 2009; Weisdorf, 2005). However, this agrarian way of life gave way later to an urban and industrial period characterizing a second economic and social paradigm shift: the Industrial Revolution (See, for example, a historical account of the Industrial Revolution: Landes (1969)). It is no longer a question of reproducing what nature produces, but of producing material or immaterial goods that only the human imagination was able to conceive from the accumulation of techno-scientific knowledge. Since then, human life has been subject to an accelerated pace of change, both intentional and unintentional, resulting from people's creative desires, which can be more or less freely expressed according to the culture or laws of the communities to which they belong.

This brief historical overview highlights the growing importance of creativity in the human way of life. In 2010, creativity was cited as one the most important characteristic according to more than 1400 CEOs and global business leaders. But this creative capacity is also solicited among employees, who are increasingly being asked to contribute to the collective creativity of their companies. The objective of this entry is to examine the role of creativity in our modern economies and its power as an agent of change.

An Economy Without Creativity

Imagine a fictitious country populated by individuals with creative abilities but whose culture or law prohibits them from using them. Throughout their lives, individuals are required to respect the order of things in force. At school, teachers teach students the accepted knowledge and punish those who dare to question it or try to discover new ideas. As adults, individuals spend part of their available time producing the set list of goods and services according to imposed technologies inherited from the past. Because private ownership of the means of production is allowed and prices are free, the supply and demand for goods and services adjust to market prices and vary according to consumer preferences. The list of goods and services on the market is therefore fixed, but the quantities produced vary according to consumer demand.

Such a market economy, where creativity is prohibited, is synthesized within Robert Solow's macroeconomic model, which proposed a mechanism for the growth of economic activity based on a given technology inherited from the past and two factors of production, labor and capital (Solow, 1956). Workers can thus use tools and machines (capital) manufactured by these same workers according to manufacturing plans inherited from the past to produce the goods and services listed on the known list. In a formal way, the supply of goods and services sold on the markets is represented by the following aggregate production function:

$$Y_t = Af(K_t, L_t) \quad (1)$$

[☆] *Change History:* August 2019. Todd Lubart updated the text throughout the article.

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where Y_t , the output (i.e., the Gross Domestic Product of the fictitious country), is the quantity of goods and services produced and sold at market prices in the country in year t , K_t and L_t are, respectively, the quantities of physical capital stock and labor used for the production of output in year t , f is the transformation function of inputs (K and L) into output (Y) and A represents the level of productivity with which the country is able to transform these inputs into the output.

Is economic change possible in this fictitious country? If so, can this change translate into economic growth (i.e., an increase in per capita income over time)? Economic change is possible in such a country but it is limited. Some characteristics are invariant. As indicated in Eq. (1), the level of productivity A and the production processes represented by f are constant in this economy. Output Y , capital K and labor L are homogeneous goods, i.e., that their characteristics cannot change. In contrast, the quantities of Y , K and L can vary upwards as well as downwards. For example, labor L varies according to population growth. The capital K varies according to the number of machines manufactured and the number of machines that have become unusable. Output Y depends on the quantities K and L used in the production processes. Economic change is therefore possible but limited to a single source: the variation in the ratio of quantities of factors of production used in production, known as the capital-labor ratio (K/L).

Is this limited economic change sufficient to generate economic growth? Assuming that marginal returns to capital and labor decrease as their quantities increase, Solow (1956) showed that such an economy could grow in the short term but not in the long term. In the short term, the accumulation of capital stock per worker, i.e. the change in the capital-labor ratio (K/L), allows an initially underdeveloped economy to grow temporarily. Growth ends when the return on capital does not allow investment beyond what is necessary to replace capital that has become unusable over time. In other words, our fictitious country can experience temporary development by providing tools and machines to workers and thus produce more of the same official list of goods and services. This capital therefore allows workers to be more productive. Each time workers receive an additional quantity of tools and machines, they produce more but with an increasingly lower return. Workers' productivity therefore reaches a maximum over time when the production resulting from an additional quantity of capital just covers the cost of that capital. Beyond this maximum, the cost is higher than the gain, which reduces workers' productivity. There is therefore a level of the capital-labor ratio above which growth in income per worker is no longer possible. A decline in population growth or a change in individual preferences may temporarily raise the per capita income growth rate above zero, but in the long run, this growth rate will always eventually return to zero.

In summary, a country, where creativity is prohibited, may experience limited economic change and temporary economic growth but not the long-term growth that has characterized Western countries' growth since the Industrial Revolution.

Innovation: The Engine of Modern Economic Growth

Solow (1957) sought to estimate the share of US economic growth between 1909 and 1949 that could be explained by the change in the labor-capital ratio. Despite the difficulty of measuring capital, his calculations showed that whereas US per capita income had doubled over this period of 40 years, only about 12% of this growth was attributable to capital and labor growth. This result has been repeatedly confirmed by other studies thereafter, for the United States but also for other countries. As for the remaining 88% of growth, economists have called it the "Solow residual", i.e., according to Abramovitz's (1956) famous formula, "a measure of our ignorance"!

Solow's work illustrated how the accumulation of factors of production (capital and labor) is a necessary but not sufficient condition to explain the continued economic growth that Western countries have experienced since the Industrial Revolution.¹ Economists have therefore sought to explain Solow's residual.² The roadmap was ultimately clear. It was sufficient to release all the assumptions of invariance in Solow's model:

1. Productivity is not fixed but progresses over time through the critical evaluation of acquired technological knowledge and the production of new knowledge to improve productivity. This change in technological knowledge raises its level, represented by variable A , which becomes A_t in Eq. (1) because it now varies over time.
2. Production processes are not invariant but change with technological progress and the experience (learning by doing) acquired by producers. The efficiency of these production processes improves over time if they are more economical in terms of production factors. The function f , representing these production processes, therefore becomes f_t in Eq. (1) because it can change over time.
3. The labor force L is not a homogeneous force fixed in time. Workers' productivity changes with knowledge acquired at school and in the workplace. In other words, the labor force can also change qualitatively as a result of the progress of knowledge. The labor force thus becomes a kind of capital, human capital, in which society can invest.

Part of this human capital consists of a set of cognitive, emotional and conative resources relevant to creativity. The level of these resources can develop throughout an individual's life and varies mainly between individuals. A large body of research in psychology investigated the precise nature of the set of resources that support creativity. Two points deserve to be highlighted.

¹According to historical statistics by Maddison (2001), per capita income in Western European and North American countries grew at an average annual rate of between 1.5% and 2% over the period 1820–2000.

²These economists belong to the research field of endogenous growth theory. The main contributions of this theory are due to Lucas (1988), Romer (1990), Aghion and Howitt (1992) and Grossman and Helpman (1993). See Aghion and Howitt (2008) for an overview of this literature.

The first concerns the likely non-linearity between these resources necessary for creativity (Rubenson and Runco, 1992; Sternberg and Lubart, 1995). Whereas a minimum level of resources is required to show creativity, excessive amounts of certain resources (such as evaluative ability) may show diminishing contributions to creative performance. The second is a potential inverted U-shaped relationship between knowledge and formal education (Simonton, 1997). School allows individuals to acquire existing knowledge, thus enabling new generations to avoid reinventing the wheel and making known mistakes. However, as the individual acquires existing knowledge, flexibility of thought may be reduced, and calling the acquired knowledge into question may be seen as devaluing one's hard-earned cognitive assets.

- 4/ Physical capital K is no more homogeneous than labor. Workers are able to improve existing machines and invent new ones. The capital can therefore also change qualitatively.
- 5/ Output Y is not an official list of goods and services. Producers are able to change the quality of existing goods or manufacture new ones. The list of varieties of the supply is therefore variable.

Eq. (1) then becomes

$$Y_t = A_t f_t(\alpha_t K_t, \gamma_t L_t) \quad (2)$$

where year t symbolizes the variation of all components of production over time, α_t is the efficiency of capital K_t and γ_t is the efficiency of labor L_t . Production is now no longer a fixed but a variable list of goods and services

$$Y_t = \sum_i^{N_t} p_{i,t} y_{i,t} \quad (3)$$

where $y_{i,t}$ are the quantities produced of these goods and services whose N_t list varies over time. These goods and services are sold at market prices $p_{i,t}$.

All the changes mentioned above are qualitative changes that can be made to the production of goods and services. These qualitative changes are what economists call innovations made by individuals with creative abilities. In economics, innovation can be defined as "the application of new ideas to the products, processes, or other aspects of the activities of a firm that lead to increased value" (Greenhalgh and Rogers, 2010, p. 4).

Formerly, the value created by innovation at the firm level is equal to

$$V = q - c \quad (4)$$

where V , q and c are, respectively, the nominal monetary net value, the nominal sales revenues and the nominal cost of the innovation. The cost of innovation refers to the production costs of the innovation and, in addition, the expenditures on research and development which made it possible to design the innovation before it was produced. This cost thus includes expenditure on capital, labor and intermediate consumption necessary for the design and production of the innovation. The value created by innovation is included in the firm's total profits. If $V \geq 0$, then the innovation is a success. Otherwise, it is a failure.

At the source of any innovative process, there is a new idea and the new idea is the output of a creative process. Psychological research on creativity provides insight into this creative process. Creative ideas seem to come from a combination/association of remote concepts. The association of remote concepts does not proceed in a random way but is guided by a selection process that depends on the knowledge of individuals as well as their emotions. Lubart and Getz argued that emotional information is a key resource in the preconscious processing of concept combinations and certain emotional abilities are essential for the recognition of these combinations. In firms, the creative process is more and more collective. It is therefore essential for them to activate the cognitive and emotional resources of employees to foster the development of creative ideas at the individual and collective level.

An innovation is therefore a creative idea that has found a market opportunity. If culture or law allows individuals in our fictitious country to use their creative abilities, then human creativity can exert a powerful force for change in the economy.

Can the economic change resulting from human creativity fill the remaining Solow residual and thus explain long-term economic growth? Eq. (4) shows clearly that if $V \geq 0$ then innovation brings a benefit to the firm. Economic change is therefore positive at the microeconomic level, i.e. at the level of the innovative firm. But is it necessarily positive at the macroeconomic level? In a creative economy, new goods and services enter the market alongside and in place of existing goods and services. In other words, innovations create new activities and jobs but also destroy existing activities and jobs. This phenomenon, described by Schumpeter (1942) as 'creative destruction', can take place within the innovative firm itself, when it sells several competing products, and between firms. Among the beneficiaries of innovation are the innovative firm itself and other firms that would use this innovation in their production process (see Creative Destruction). This innovation is then either a new good or service entering the manufacturing process (intermediate consumption), a new capital good (factor of production) or a new manufacturing method (production process). In any case, innovation, through an externality effect, offers a value gain to those firms that use this innovation without having created it. Among the victims of innovation are firms that suffer a loss of value as a result of the competitor's successful innovation. But if this innovation does not allow the innovative firm to cover its research and development costs, then the innovation causes it to suffer a loss. Innovation therefore has a positive macroeconomic effect if the value created in the economy outweighs the value destroyed (see Corporate Creativity).

Is this always the case? In a competitive economy, the answer is yes. Every day, firms compete to sell their goods and services to buyers who are consumers in the business-to-consumer market and firms in the business-to-business market. Because buyers'

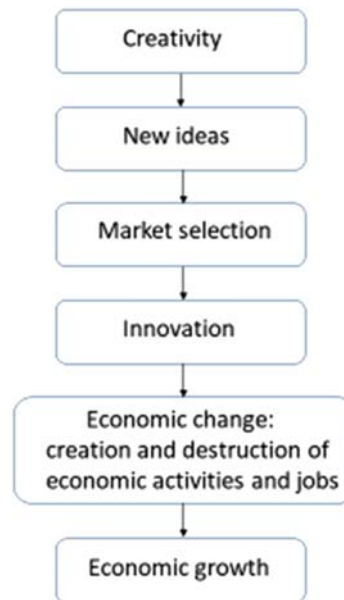


Figure 1 A Simplified Growth Model of Creativity.

budgets are limited, firms must do everything possible to ensure that the quality and price of their goods and services convince buyers. While competition regulators ensure that free market entry is respected, competition operates not only between existing firms but also with new firms entering the market. This competition is the market incentive that drives firms to use human creativity to improve their supply of goods and services through more attractive quality at the best price. Competition thus promotes the emergence of creative ideas and the market, i.e. the demand expressed by buyers, selects the most efficient. The innovations sold on the market are necessarily the creative ideas that have overcome all the challenges of the competition. To remain or be more efficient, firms must research and succeed in their innovations. Thus, in competitive markets, firms that succeed in maintaining or increasing their efficiency push out those whose efficiency is declining. For this reason, the macroeconomic effect of innovation is necessarily positive (see Fig. 1 for a model of growth processes resulting from creativity) (see Innovation).

How can this net macroeconomic value creation be measured? A first approach consists of using company accounts as a starting point. But because innovation creates and destroys value, it is difficult to identify the costs and benefits of innovation in firms' accounts and thus to obtain, by aggregating these costs and benefits, an indicator of the macroeconomic effect of innovation. The other approach is based on the measurement of economic growth, i.e. the variation over time of firms' added values. However, as already mentioned, economic growth is the result of economic change resulting from a quantitative change in production factors and qualitative economic change resulting from innovation. However, the decomposition of growth proposed by Solow (1957) made it possible to roughly distinguish the two. The Solow residual can therefore be considered as a measure of the macroeconomic effect of innovation. Given the size of this residual in most empirical studies, it can be concluded without reservation that innovation is the driving force behind long-term economic growth.

However, although positive, the creation of net macroeconomic value has an economic and social cost as new firms emerge and create jobs whereas others disappear with their jobs. In addition, the jobs created often require different qualifications from those of the jobs destroyed, forcing workers to undergo lifelong training to adapt to the requirements of new jobs. This reallocation of jobs from declining to innovative firms benefits mainly new generations and the most skilled workers.

Why Do Firms Innovate?

Economists assume that a firm's objective is to maximize its profit. In a competitive market, profit maximization aims to avoid the risk of the firm's bankruptcy. Audretsch (1991) estimated on US data that only one in two firms was still in business after 6 years and one in three after 10 years. The same author observed that US firms that innovated increased their probability of survival.

As already explained, innovative firms that manage to gain a foothold in competitive markets have *de facto* convinced buyers with new, better or cheaper products. As the buyers' budget is limited, there is not room for everyone. This is why innovative firms drive firms that are less innovative or not sufficiently innovative into bankruptcy.

Competition is therefore a powerful incentive to seek innovation. For this, firms have two possibilities. Either they organize within themselves a research and development department to generate creative ideas that they use for their benefit or that they

sell on the market, which can be called the creative ideas market. Either they buy creative ideas from individuals, universities or other firms in the same creative ideas market. Some firms use both possibilities.

But this has a cost that is not always rewarded. There are many innovations that fail, which also explains the high mortality rate of firms. They must therefore decide between the risk of going bankrupt because they do not innovate and the risk of going bankrupt because their innovations fail. Moreover, even if their innovations are successful, firms face an additional risk: the theft of creative ideas in various forms such as industrial espionage, imitation or counterfeiting. This risk is an existential threat not only to innovative firms but also to the economy as a whole because firms cannot protect themselves against this risk on their own. The creative idea is a “good” that is easy to steal because of its particular characteristics. It is an inappropriable good, i.e. the good is non-rival (several people can consume the same good at the same time) and non-excludable (it is difficult or even impossible to prevent others from consuming the good by varying its price). There is therefore a strong temptation for firms to appropriate the creative ideas of other firms as soon as they are communicated and to sell the resulting innovations to buyers who can benefit from them at immediately competitive prices. Everyone benefits from creative ideas except, sometimes, the firms that produce them.

That is where the problem lies. These creative firms invest money in research and development to generate new ideas. If the market price of the innovations resulting from these ideas is not high enough, then the profit of these firms will not cover the initial investment. If competitors can appropriate creative ideas without having to buy them, why should firms make the effort to spend on research and development to produce them? Arrow (1962) showed that production in a market where the good is inappropriable by its producer was socially non-optimal. This market failure is serious.

On the one hand, it is desirable that access to creative ideas be as broad as possible. Indeed, the creative idea is not the result of an *ex nihilo* process. It is always built on knowledge, experience, existing ideas and informational exchanges between individuals. In turn, the creative idea enriches the stock of existing knowledge that will inspire other creative ideas. This stock of knowledge accumulated over time must therefore be a collective ground from which individuals or teams from firms can draw their inspiration. However, it is desirable that the production of creative ideas be rewarded in one way or another, without which the stock of knowledge cannot progress.

The market alone cannot guarantee both the production of creative ideas to increase the stock of knowledge and the widest possible access to it. The probably imperfect solution that market economies have provided to this market failure is legal rules and regulations: the creation of an intellectual property right for authors of creative ideas and temporary legal protection of innovations (patents and copyrights). Thanks to this legal protection, innovative firms make their new ideas available to the public in exchange for a time-limited payment for the use of these ideas by other firms.

Firms can therefore apply for legal protection of their inventions to a patent office, which must decide on their creativity in order to grant it. The first law on the protection of inventions (*Parte Veneziana*) was promulgated by the Republic of Venice in 1474. This law is the historical testimony of the importance of the economic value taken from that time on by creativity and the difficulty of inventors to appropriate this value. Since that time, as evidenced by statistics from the World Intellectual Property Organization (WIPO), the demand for legal protection of inventions has increased steadily, confirming more than ever the economic value of creativity and the vital need for firms to innovate (see Patents).

Creativity: The Unlimited Frontier of Economic Development in a Finite Environment?

Throughout history, humans have exploited their potential to create resources, material and immaterial goods. This production enabled the demography of the human species to grow rapidly and has profoundly changed people's way of life (Livi-Bacci, 2017). Humanity's tremendous economic development is largely the result of human creativity. If this creativity can be encouraged, then economic development will be enhanced. However, creativity, and resulting productivity and economic growth also impact the balance within human societies and between humans and the planet. It will require additional human creativity to solve challenges facing the world, be they environmental or social, which themselves have resulted from activity at the interface between creativity and economics.

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Education

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Education and Creativity

Creativity occupies a somewhat paradoxical role within formal K12 and higher educational settings. Although educators have long viewed educational settings as a promising context for the development and expression of student and teacher creativity, schools and classrooms have also been characterized as sites of creative suppression. Moreover, empirical work has demonstrated that the relationship between creativity and academic learning tends to be highly variable across schools, classrooms within the same schools, and even at different points of lessons within the same classroom (Gajda et al., 2017).

One way to understand the variable and, at times, paradoxical role that creativity plays in educational environments is to recognize that schools and classrooms, like all contexts, place constraints on creativity. Consequently, the role creativity plays in any given educational environment will, in large part, be determined by how it is conceptualized in that particular setting.

The opportunities and support for creative expression will, for instance, be very different in a classroom that where educators conceptualize creativity as complementing their academic goals versus a classroom in which creativity is viewed as competing with those aims. Recognizing how different conceptualizations of creativity can have different implications for whether creativity is supported or suppressed can go a long way in helping researchers and educators better understand the role creativity plays in educational contexts.

The purpose of this entry is to provide an overview of various ways creativity has been conceptualized in educational environments, discuss implications for creative expression, and briefly highlight directions for research and practice.

A Continuum of Conceptions

The role creativity plays in educational settings can be thought of as ranging on a continuum from contradictory and ancillary to complementary and primary (see Fig. 1).

One side of the continuum displayed in Fig. 1 portrays conceptualizations that tend to suppress creativity (i.e., viewing it as contradictory or ancillary to the goals of an educational setting) and the other portrays more creativity supportive conceptualizations (i.e., viewing it as complementary and primary to education). Prior to discussing each of the four conceptualizations on the continuum and the implications for creativity, it is important to highlight a few assumptions regarding the continuum.

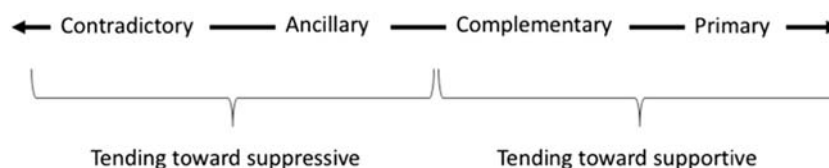


Figure 1 Continuum of Conceptualizations.

As with any continuum, the areas of the continuum do not represent discreet categories, but rather blend into each other. Moreover, as mentioned there is variability in and across classrooms with respect to the role creativity plays in educational settings. As a result, although a given educational setting may tend to be represented by a more or less supportive conception of creativity, there likely will be some level of variability in the day-to-day and moment-to-moment support of creativity in any given environment. Recognizing that variability still remains within any given environment helps avoid characterizing educational environments in overly simplified ways, prevent missed opportunities to study and realize the creative potential in a particular learning environment, and acknowledge the dynamic and complex nature of educational settings.

Creativity as Contradictory

The first position on the continuum represents a contradictory conception of creativity. A contradictory conception refers to *viewing creativity as being in direct competition with academic goals*. This view places creativity and academics in a zero-sum relationship. Consequently, educators who hold this view may feel that using curricular time to provide opportunities for creative expression likely takes away from more pressing and basic academic goals.

An extreme example of the contradictory perspective is represented in the proclamations of the fictional educator, Thomas Gringrand, in Charles Dickens' *Hard Times*:

Now, what I want is, Facts. Teach these boys and girls nothing but Facts. Facts alone are wanted in life. Plant nothing else, and root out everything else ...
Dickens (2012, p.5)

Although Gringrand is a fictional character, the idea of focusing on basic academic facts is a view that occasionally surfaces in the "back to basics" discourse of educational policymakers and designers of school reform initiatives. In the context of this type of educational policy and discourse, aims such as nurturing student creativity are conceptualized as superfluous.

Research on practicing educator's beliefs suggests that teachers tend not to espouse such an explicitly narrow view of the aims of education. There is, however, evidence that some educators hold a contradictory view, which may be a result of the perceptions they hold and contextual pressures they face. Specifically, prior research demonstrated that some teachers tend to favor conforming behaviors in students (Karwowski, 2017). Moreover, there is evidence that even prospective teachers tend to view creativity as being incompatible with academic learning. Prior research indicates that prospective teachers tend to view cultivating the creative imagination as something that should eventually be replaced with a more serious focus on the memorization of academic subject-matter or something that should be deferred until some later point once students have established a firm academic foundation (Beghetto, 2013).

The contradictory perspective differs from how scholars tend to view the relationship among creativity, academic facts, meaningful memorization, and academic learning. Specifically, educational and creativity scholars have traditionally viewed creativity and learning as compatible and mutually reinforcing experiences. Consequently, scholars often raise concerns when an overly narrow focus is placed on rote learning, memorization, recall, and recognition as they tend to assert that it unnecessarily diminishes opportunities to simultaneously foster creative and academic potential. David Berliner (2011), for instance, asserted that such restrictive educational policies and externally mandated testing practices have dire consequences both for creativity and "what it means to be smart in school" (p. 79).

Implications for Creativity

Educational systems which operate under the assumption that creativity and academic learning represent contradictory aims, likely will suppress creative expression and the development of creative productivity. Indeed, if creativity is viewed as taking away from educator's primary responsibility, then it makes sense that, in practice, educators would disapprove of anything that contradicts their primary professional aim. One consequence of this is that even unexpected and potentially creative ideas shared during classroom discussions likely will be deflected (e.g., "We'll talk about this later") to avoid the risk of being derailed from their previously planned academic lesson.

Creative experiences can still operate within the context of educational environments that conceptualize creativity as contradictory. Creativity researchers have long recognized that subjective forms of creativity occur anytime someone has a new and personally meaningful insights, interpretations, or experiences. The problem, of course, is that students need to have opportunities to receive feedback on their own unique conceptions. This is important both for learning and creativity.

With respect to learning, students need to be able to test-out their ideas and receive corrective feedback on any confused, muddled, or inaccurate academic conceptions. As for creativity, students also need opportunities and feedback to help them communicate unique and meaningful conceptions so that those ideas can make a contribution to the learning and perspectives of others. If creativity is conceptualized as a contradictory educational aim then it likely will curtail the encouragement and feedback necessary for creative expression and limit opportunities for students to develop their creative productivity.

Creativity as Ancillary

Moving along the continuum of conceptions, the next way that creativity can be conceptualized in educational settings is to view it as a potentially beneficial but ancillary goal. An ancillary conception therefore refers to *viewing creativity as a valued, but minor aim of education*. Much like conceptualizing creativity as a contradictory goal of education, viewing creativity as an ancillary, albeit valued aim of education likely will result in creativity being differed or dismissed. This is why an ancillary aim falls on the tending toward suppressing end of the continuum (Fig. 1).

Prior research suggests that an ancillary conception of creativity may be the most widely held view amongst educators. Consider, for instance, the results of a systematic review of 18 studies on teachers' perceptions of creativity published from 1999–2015 (Mullet et al., 2016). The authors of the review reported that teachers tend to value creativity but typically believe it is limited to the arts and feel unprepared to foster it in their classrooms. Such beliefs reveal an ancillary perspective. Specifically, when creativity is viewed as valued, but separate from what teachers have been prepared and are expected to teach, then it likely will receive little if any attention.

This ancillary view was also prevalent in the findings of another systematic review of 53 studies published from 2010 to 2015 on K12 teachers' beliefs about creativity (Bereczki and Kárpáti, 2018). The authors reported that teachers tend to hold a generally positive view about creativity (e.g., "generally value creativity", "believe that it can be nurtured in every student"), but also tend to believe that they are not capable of fostering creativity due to various barriers that characterize their professional practice (e.g., "lack of time and training," "overloaded curriculum"). The consequence, as the authors of the review explained is "even if teachers hold positive or adequate beliefs about creativity, these rarely translate into creativity-fostering practices" (Bereczki and Karpáti, 2018, p. 50).

Implications for Creativity

When creativity is a valued yet an ancillary aim, teachers may feel as though it is not their direct or most pressing responsibility. Consequently, opportunities for creative expression tend to be suppressed because teachers feel the pressure (self-imposed or otherwise) to focus on more pressing academic aims.

As mentioned, one reason this can happen is because teachers feel overloaded by their primary academic curriculum. Indeed, teachers who would otherwise "like to help students develop creativity" tend to feel "overwhelmed with other more pressing responsibilities" (Aljughaiman and Mowrer-Reynolds, 2005, p. 30)

Another reason this can happen is if teachers do not feel they have had adequate preparation or opportunities to support creative expression in the context of their academic subject matter teaching. Indeed, Chan and Yuen (2014) explained based on their study of teachers in gifted and general education that supporting creativity in the classroom may come down more to environmental supports, opportunities, and resources to implement creativity supportive practices rather than substantial differences in creative personality or valuing creativity.

Viewing creativity as an ancillary goal of education is not limited to practicing teachers. Prior research on prospective teachers also indicated that they generally value creativity, but tend to view it as being more aligned with the arts and have concerns that spending time exploring creative ideas during the teaching of academic subjects may take them "off track" from their primary curricular responsibilities (Beghetto, 2013). It therefore may be the case that future educators enter into the profession already holding ancillary conception of creativity, which carries over and continues into their professional practice.

Consequently, translating a value for creativity into opportunities to foster students' creative productivity in the curriculum, may come down to educators learning how creativity can complement their academic goals.

Creativity as Complementary

The next point on the continuum of conceptions is a complementary perspective. This perspective *refers to viewing the development of creative productivity as being compatible with academic learning and academic learning as being compatible with fostering creative expression*. A complementary perspective positions creativity and academic learning as having the potential to be mutually reinforcing. It is a both/and perspective, which recognizes that although there are differences between creativity and academic learning there is a positive relationship between the two.

Viewing creativity as compatible with academic learning is a view that has long been held in the creativity studies literature. J.P. Guilford (1950) explained that "a comprehensive learning theory must take into account creative activity" because "a creative act is as an instance of learning" (p. 446). Learning theorists, including Jean Piaget and Lev Vygotsky also recognized that the creative imagination plays a central role in the development of knowledge. Recent theoretical perspectives have also characterize creativity and learning as compatible (see Beghetto, 2016 for an overview).

One reason scholars conceptualize creativity as being complementary to educational goals is because it represents a blend between *originality* (i.e., uniqueness, novelty or effectiveness) and *meaningfulness* (i.e., usefulness, effectiveness or meeting task constraints). In the context of an educational setting, academic subject matter can serve as the task constraints and originality represents different ways for teachers and students to meet those constraints.

Creativity researchers have also examined the empirical link between creativity and academic achievement. A meta-analysis (Gajda et al., 2016) examined 120 studies and 782 effects from research conducted from 1962–2015 and found a positive, albeit

modest association ($r = 0.22$) between measures of creativity and academic achievement. This somewhat modest, yet positive relationship is, in part, due to the variability in the types of measures used and variability of the relationships found in studies included in the metanalysis. Indeed, previous research found positive, negative, and null relationships between creativity and academic learning.

Although there seems to be a generally positive association between measures of creativity and academic learning, a key take-away from the complementary perspective would be although creativity can be compatible with academic learning, there likely is a great deal of variability in how this plays out in educational settings. A recent, mixed-methods study (Gajda et al., 2017), for example, examined the variability of creativity supportive behaviors in ten classrooms classified as having a positive (average $r = 0.52$), negative (average $r = -0.23$), and null (average $r = 0.02$) relationship between creativity and academic learning. The findings from this study suggest that classrooms classified as having a positive creativity-academic achievement relationship tended to be characterized as having teachers who demonstrated caring behaviors, emotional support, more extended opportunities to explore and develop student ideas creativity supportive behaviors. Importantly, however, student self-expression and ideation were found across all classroom types. Moreover, redirecting and dismissal of students' ideas also occurred in all classroom types and there was also evidence that creative teaching and learning behaviors may be difficult to sustain over the duration of the entire lesson.

Taken together these results indicate that creativity can be compatible with educational aims across various classroom types, but that there is variability in when, how, and why creativity plays a compatible role in particular classrooms at a particular point in time.

Implications for Creativity

A complementary perspective therefore recognizes that opportunities for encouraging and exploring creative ideation in the context of academic learning is possible, although not always feasible or necessary during every moment of academic learning. In this way, a complementary view of creativity acknowledges that there is a time and place for creative expression. It is not always beneficial or necessary for students to come up with their own unique way of meeting academic expectations or meeting academic criteria. Indeed, learning pre-existing ways of thinking and acting can not only be beneficial for learning but also for creativity.

In this way, highly planned learning environments, which require students to fulfill predetermined expectations or criteria do not necessarily stifle creativity. In fact, as long as educators blend pre-determined features with to-be-determined aspects, then they will actually be planning for creativity by including opportunities for students to meet pre-established educational goals and criteria in different ways.

A complementary perspective thereby recognizes that educators need not always try to teach creatively or require creative expression on the part of their students, but rather provide young people with frequent opportunities to develop, test-out, and contribute their unique insights and perspectives to what they and their peers are learning.

Creativity as Primary

The final conception on the continuum involves viewing creativity as a primary educational goal. Much like a contradictory conception, the creativity as primary perspective represents a somewhat extreme end of the conceptual continuum. In some cases, viewing creativity as a primary educational aim has historically had a basis in theological beliefs or viewing creativity as central to what it means to be human. Such views have most frequently been evident in the design of early childhood environments.

Fredrich Froebel (1782–1852), the German educator and progenitor of the concept of the kindergarten, represents one of the earliest examples of an educator conceptualizing creativity as a primary aim in the design of educational practices. Froebel's ideas, which had theological overtones, outlined a pedagogical approach aimed at fostering children's creative activity. Froebel based his educational views on his belief that children were inherently creative beings and thereby required an education that provided opportunities for students to engage in creative activity, effort, and development (Hill, 1908).

Other examples of educational environments that viewed creativity as playing a primary, albeit more integrated role include the American Pragmatist John Dewey's Laboratory School at the University of Chicago, which had an aim to "respond to the child's need of action, of expression, of desire to do something, to be constructive and creative, instead of simply passive and conforming" (Dewey, 1990, p. 80). The Reggio Emilia approach to education is another example. Developed after World War II by the educational psychologist, Loris Malaguzzi, in collaboration with educators, parents, and children from Reggio Emilia, Italy. This approach, much like other child-centered approaches (e.g., Montessori and Waldorf), views educational settings as places where "children and adults may realize their full potential as intelligent, creative, whole persons" (Edwards and Gandini, 2018, p. 368).

In addition to early childhood environments, arguments in favor of conceptualizing creativity as a primary educational aim tend to be offered as a corrective to what is perceived as educational settings placing too narrow of an emphasis on memorization and recall. Arguments in favor of viewing creativity as a primary educational goal sometimes position it as being *the* most important goal, which represents the most extreme version of this conception.

The American creativity researcher, Frank Barron, for instance, observed that during the late 20th century in the United States a "growing core" of educators and educational programs endeavored to place "creativity as the most important goal of education" (Barron, 1969, p. 7). Similar views have been asserted in other countries and occasionally resurface across the decades. The British

philosopher, Mary Warnock, argued that educators have a duty “above all else” to develop the child’s creative imagination (Warnock, 1978).

In other cases, arguments in favor of creativity as a primary goal describe it as a distinct but equally important aim as academic learning. The author and speaker Sir Ken Robinson, for example, asserted in his incredibly popular 2006 Ted Talk (*Do schools kill creativity?*), “creativity now is as important as literacy, and we should treat it with the same status.” Gifted education programs have also conceptualized creativity and academic learning as important but distinct curricular streams.

In still other cases, scholars and educators who view creativity as a primary aim also recognized that it overlaps with academic learning and thereby hold views that start to blend with a complementary conception. As mentioned, the Soviet educational psychologist, Lev Vygotsky viewed creativity and academic subject matter as complementary. Vygotsky, however, also asserted that if preparing young people for the future is the main educational goal, then fostering the creative imagination “should be one of the main forces enlisted for the attainment of this goal” (Vygotsky, 2004/1967, p. 88).

Implications for Creativity

Viewing creativity as *the* or *one of the* most important educational goals, can result in multiple opportunities for creative expression. Such educational environments however tend to be an alternative to the prototypical K12 or college educational environment (e.g., early childhood settings, creativity-focused gifted education programs, specialized schools, or after school programs). There are also emerging settings that offer a creative third space for students and educators.

A creative third space provides students with opportunities to engage in creative projects and endeavors in a space between their typical academic program and their surrounding community. *IowaBig* is an example of a creative third space, which provides opportunities for students to take creative action on real-world problems. Iowa BIG is a public high school program, with no admissions requirements, which partners with school districts in Iowa and provides students and families with a “different learning experience” (lowabig.org). Specifically, students attend Iowa Big for 50%–90% of their school day to design a creative, interdisciplinary project that requires students to work with outside partners to work on addressing problems and community needs generated by students and local businesses, non-profits, and government agencies (lowabig.org). Conceptualizing creativity as a primary aim of education can result in experiences tending toward supporting creativity, but such a conception can, somewhat ironically, also result in the marginalization of creativity (at least in prototypical K12 and college settings). Indeed, given that most K12 and higher education systems have already firmly established academics as a primary aim, attempting to replace or compete with academic learning for curricular space likely will result in creativity being displaced or outsourced. Consequently, much like a contradictory or ancillary perspective, educational programs that have a primary aim of encouraging creative expression and fostering creative productivity tend to relegate it to specialized and extracurricular educational programs.

Conclusion

The purpose of this entry was to highlight how different conceptions of creativity can have implications for whether it is supported or suppressed in educational environments. One key insight for both researchers and educators is to avoid the temptation of characterizing educational environments as monolithic. Educational environments do not necessarily suppress creativity. Creativity still occurs even in environments that view it as contradictory to the aims of education and creative expression is also sometimes suppressed in environments that value it and actively attempt to encourage it.

Creativity researchers interested in understanding creativity in educational environments therefore need to take the time to understand the unique features and aims of the settings they are studying. The use of blended methodologies that employ more dynamic and micro-longitudinal designs can help reveal the variability of creative expression both within and across educational contexts.

Moreover, researchers who take the time to work more closely with practicing educators likely will develop a better understanding of the unique constraints teachers face as well as what things teachers are doing to support student creativity. Teachers (both prospective and in-service) can also learn from researchers how creativity has been conceptualized in the field of creativity studies, how it might complement their academic aims and responsibilities, and how to strike a better balance of knowing when, how, and why to support creative expression in the context of their other academic aims.

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Relevant Website

Creativity in the Classroom, American Psychological Association, <https://www.youtube.com/watch?v=oQqFFaJJ8gc>.

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Introduction

One of the most urgent problems in the scientific study of creativity is precisely how to define the phenomenon. By what criterion does a researcher identify one subject as creative? The published literature is replete with rather diverse operational definitions. Most often, however, individuals are said to display creativity when they score sufficiently high on a so-called creativity test. Yet clearly, such identification only begs the question: How do we know that the psychometric instrument actually measures creativity? Obviously the test must undergo some type of validation. For instance, the test might be validated by determining if those who score high on the measure can generate products or ideas that are judged creative by others. But this merely sweeps the problem under yet another rug. Who shall we rely on to perform these judgments? [See Testing/Measurement/Assessment.]

One reasonable resolution to this measurement quandary is simply to say that individuals who have received broad acclaim for their creative contributions can be safely deemed creative. Such a definition seems sound on *prima facie* grounds. In the parlance of psychometrics, an eminence measure of creativity has “face validity.” Note that creative eminence also solves a host of other methodological niceties as well. For example, another difficulty in the investigation of creativity is how to define different types or levels of the phenomenon. How does the researcher distinguish artistic from scientific creativity? How does the investigator gauge the magnitude of creativity? From the standpoint of the eminence criterion, the response to both questions is direct. Individuals who attained distinction for contributions to the arts are artistic creators, whereas those who earned applause for contributions to the sciences are scientific creators. Therefore, Picasso exemplifies artistic creativity, whereas Einstein exemplifies scientific creativity. Similarly, the higher the level of fame achieved, the greater the presumed level of creativity displayed. By this judgment, accordingly, Johann Sebastian Bach is deemed more creative than, say, Georg Gebel the Elder, his exact contemporary and compatriot.

As the foregoing discussion suggests, the eminence criterion of creativity may be employed two distinct ways:

1. In the simplest usage, eminence is adopted as a sampling criterion. Individuals who exhibit sufficient excellence in a creative domain are selected for inclusion in the researcher’s sample. For instance, when Ann Roe (1953) wished to understand the basis for scientific creativity, she sampled a group of 64 eminent scientists based on expert appraisals. Sometimes the eminence criterion is also used to single out subjects for the control group. A good example is the approach taken by researchers at the Institute for Personality Assessment and Research at the University of California at Berkeley (Feist, 2014). Wanting to understand the basis for creativity in architecture, the investigators recruited the participation of some rather renowned members of that profession. But the researchers also obtained the participation of far less successful colleagues who could provide the basis for comparison. [See Consensual Assessment.]
2. The other role of eminence is as a continuous variable used to measure individual differences in creativity. Just as the amount of creativity may vary from person to person, so may the amount of eminence exhibit considerable cross-sectional variation. To the extent that the fame of creators is founded on the magnitude of creative achievement, the degree of distinction should be directly related to underlying creativity. Such an eminence indicator of creativity is employed three major ways in the published literature. First, the eminence measure may be studied alone. The researcher may focus on the degree of variation, the distribution, the stability across time or cultures, and so forth. Second, the eminence measure may be adopted as a dependent variable in a prediction equation. In such cases the goal is to identify the factors that predict historic creativity. This constitutes the most common use of this type of creativity measure. Third, but less frequently, eminence may be used as an independent variable, especially as a moderator variable in a regression equation testing for interaction effects. For example, some inquires look at

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whether the curves defining the relationship between age and creative productivity varied according to how illustrious were the creators (Simonton, 1997). Here eminence “moderates” the relation between age and output. The interest then is not in predicting eminence but in determining whether the same career trajectories held for all individuals regardless of the magnitude of accomplishment. [See *Genius and Greatness*.]

Measurement

What are the ways that researchers go about assessing the eminence of creative personalities? What are the psychometric properties of the resultant eminence assessments? These are the questions answered next.

Assessment Techniques

Once the investigator decides to use eminence in a particular study, the first issue that must be addressed is how to best assess the eminence of the individuals under investigation. Sometimes a purely informal procedure suffices. For instance, most psychobiographical studies of creative individuals select a particular case for study precisely because that person is obviously famous (and at the same time interesting in some other way; Schultz, 2014). Thus, when Sigmund Freud (1910) did his analysis of Leonardo da Vinci, he felt no need to justify the choice of subject. The artist’s eminence would be obvious to all. Similarly, when Howard Gardner (1993) selected the seven subjects for his book *Creating Minds*, he simply picked a 20th-century luminary who represented each one of the seven intelligences according to his theory of multiple intelligence. The resulting sample consisted of Albert Einstein, T. S. Eliot, Pablo Picasso, Igor Stravinsky, Martha Graham, Sigmund Freud, and Mahatma Gandhi. Even though someone else might pick a different set of representatives, the distinction of these seven figures is beyond doubt.

One difficulty with such informal sampling methods is that they permit the potential introduction of bias. Because there is so much latitude for subjectivity, it can happen that the eminent are unconsciously selected to be consistent with some perspective or hypothesis. An interesting illustration is the sample that Abraham Maslow (1970) collected to study self-actualizing personalities. Because, as a humanistic psychologist, Maslow believed that creativity was associated with superior mental health, it cannot have been mere accident that there are no cases of truly “mad geniuses” among the creators in his sample. Sometimes the avoidance of the psychopathological made him sample the less famous rather than the more famous. Why else would Maslow choose Camille Pissaro rather than van Gogh or Franz Joseph Haydn rather than Beethoven? [See *Mad Genius Controversy*; *Self-actualization*.]

To avoid the potential introduction of bias, many investigators adopt more systematic and objective strategies for sampling eminent creators. Sometimes the researcher will study those individuals who have attained sufficient acclaim that they have biographies written about them or at least articles under their name in major reference works, such as encyclopedias or biographical dictionaries. Other times the investigator will rely on peer nominations. Experts in a particular domain will be asked to nominate those contemporaries who have made the most creative contributions. Still other researchers will adopt the criterion of the creator having received a major honor, such as the Nobel or Pulitzer.

So far the focus has been on the application of the eminence criterion as part of a sampling procedure. Yet as pointed out earlier, eminence often figures prominently as an individual-difference variable in its own right. Even among the notables of a particular creative domain, the variation in reputation can be quite substantial. The question then becomes how to best capture this dispersion in terms of reliable scores on some eminence measure. One of the oldest and most common solutions is to use standard reference sources to define some type of space measure. For instance, the investigator might count the number of pages or lines devoted to each creator in a biographical dictionary, encyclopedia, or history. Alternatively, the researcher might count the number of books or articles written about each individual in the sample. Such archival indices of eminence have the advantage of being highly reliable and objective.

However, some investigators prefer eminence assessments that allow more room for subjective considerations. A good example is the Creative Achievement Scale devised by Arnold Ludwig (1995). This instrument requires assessments of an individual’s contributions in terms of originality, universality, versatility, influence, transcendence, virtuosity, and so on. These assessments are based on biographical and historical information available about each eminent creator. Another approach is simply to ask experts to rate eminent creators on the global level of creativity realized. Sometimes such global assessments are carried out in the form of rankings.

In any case, these subjective measures have certain advantages over the objective measures mentioned in the previous paragraph. For one thing, the subjective indicators can help the researcher understand better what exactly is being assessed, especially when the components of creative eminence are made explicit in the design of the measurement scale, as is the case in Ludwig’s instrument. In addition, the objective measures sometimes have biases that are not necessarily present in the subjective measures. For instance, archival assessments of eminence based on space measures often favor some forms of creativity at the expense of other forms. It is much easier to describe in words the contributions of writers and philosophers than it is to give a verbal account of the contributions of painters and composers. As a consequence, encyclopedias tend to devote more space to eminent individuals whose creativity took a verbal form than to those whose creativity required nonverbal means of expression. Fortunately, statistical procedures

do exist that permit the introduction of the appropriate corrections, but these procedures necessarily make the data analysis more complicated.

Psychometric Features

It should be pointed out that eminence measures have been shown to have highly desirable properties from a psychometric perspective. One striking example concerns reliability, which gauges the amount of measurement error. It turns out that indicators of individual differences in creative eminence display quite impressive reliability coefficients, which signify that the amount of measurement error is relatively small. In fact, eminence measures are just as reliable as other, more commonplace measures in psychology, such as scores on intelligence tests. Second, alternative techniques for assessing individual differences in eminence yield quite comparable results. Not only do the diverse kinds of objective measures correlate highly with each other (and the various types of subjective measures intercorrelated highly as well), but in addition the objective and subjective assessments are in substantial agreement as well. Hence, a consensus exists on the relative eminence of creative individuals. Finally, this strong consensus on differential eminence is highly stable over time. Researchers have examined eminence ratings separated by a century or more and still obtain respectable correlations. Indeed, there appears no pronounced tendency for the agreement to decline as the temporal separation between two measures increases. This transhistorical constancy of eminence suggests that differential fame is tapping into some stable individual differences in creative accomplishment. If Mozart is consistently rated as more famous than one of his contemporaries, such as Daniel Gottlob Türk, this contrast no doubt reflects to a very large extent their comparative creativity.

Admittedly, the correspondence between eminence and creativity is by no means perfect. Exceptions to the general rule do exist. Sometimes creators die before they receive the recognition they deserve (e.g., Gregor Mendel), whereas other times creators received far more contemporary fame than they will be granted by subsequent generations (e.g., Trofim Lysenko). Yet these occasions are too few and far between to seriously undermine the reliability and stability of eminence indicators.

It must also be confessed that it is the fairly irreversible fate of every luminary that his or her fame will decline with time. After all, as more and more creative products are added to the cultural store, the competition becomes ever more fierce. Each year there are ever more paintings to hang on gallery walls, compositions to perform in the concert halls, plays to be produced, books to be reprinted, and so forth. Accordingly, even the most illustrious creators are fated to see their market share gradually diminish. Yet that decline by itself does not attenuate the significance of eminence as a gauge of exceptional creativity. So long as the relative positions of eminent creators remain constant over time, the stability of eminence will persist. Hence, in the theater Shakespeare may have had to yield some ground to Shaw and other more recent playwrights, but so did Marlowe, Jonson, and other Elizabethan contemporaries. Despite the increased competition, Shakespeare's differential standing survives unscathed.

Conclusion

The ultimate justification for using eminence as an index of creativity is that it has yielded substantial insight into how creative geniuses differ from their less successful competitors for historic distinction. Highly eminent creators differ from their less distinguished colleagues on a host of cognitive, personality, developmental, and sociocultural variables. To offer a specific instance, the "mad-genius" hypothesis is supported by historiometric research indicating that creative eminence is associated with degree of psychopathology, even if the precise nature of the relation depends on the domain of creative achievement (Simonton, 2014). Thus, eminence is not bestowed in an arbitrary fashion, nor does it lack any correspondence with what is going on in the individual creator's mind.

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Genius, creativity, and leadership: Links (<http://psychology.ucdavis.edu/Simonton/p175wlinks.html>).

Emotion/Affect[☆]

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Definitions of Emotion and Affect

Concept of Creativity

A useful distinction in the conceptualization of creativity is that of the creative product as opposed to the creative process. The creative product is the output of the individual. The output is then judged according to criteria in a particular field as to its creativity. There is a consensus in the field that for a product to be judged as creative, it must be a) original, unique, novel and b) useful—that is, adaptive and aesthetically pleasing according to the standards of the particular discipline.

Given these two criteria for a product to be judged as creative, the question is often asked, “Can children be truly creative?” Although children can generate new and useful ideas and products, the products are usually not at a level of sophistication necessary to truly contribute to an area. However, if one considers whether or not a product is new and good for that age group, then children can be considered to be generators of creative products. Even though a discovery or idea may have already occurred in a field, if it is new to the individual, then it is a creative act. Ruth Richards (1993) has called this kind of creativity “everyday creativity.” Therefore, children and many adults demonstrate creative acts on a daily basis, even though the creative products are not making major contributions to a discipline like art or engineering. This is an important point because it implies that we can study creativity in children and in normal adult populations.

The creative act, which generates a creative product, can involve a number of underlying processes. A major question in studying creativity is “What are the processes that are part of the creative act?” What cognitive, affective, and personality processes are involved in the creative process and increase the likelihood that an individual will generate a creative product?

Concept of Emotion/Affect

It is important to define the terms **emotion** and **affect**. Affect has been described as a broader concept, with emotion and mood as a subset of affect. Emotion is defined as a state of aroused feeling or agitation. Affect has also been viewed as a broad set of events that includes emotions and drives, and involves feeling states that are pervasive. Emotions have been described as interrupting events that are more specific in terms of stimuli and behavioral responses that are broader feeling states. Moods are often defined as being of longer duration than emotions without a clear trigger or object. The term affect is used throughout this chapter, rather

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than emotion, because affect is the more inclusive concept. Affective processes refer to the different dimensions of affect, or types of affect events, that occur within the individual. Most theorists think that cognition frequently is involved in the affective processes, although they differ as to whether affect is always involved, the degree of involvement, and the type of involvement.

Types of Affective Processes

In 1993, Russ identified that affective processes have emerged that are important in creativity based on theory and the research literature. The five affective processes, briefly defined, are as follows:

1. **Openness to experiencing affect states.** This is the ability to feel the affects and specific emotions as they occur. Tellegen and others have found that different types of affect states can be classified as positive affect or negative affect. Individuals differ as to how much they can experience positive and negative affect states. These specific feeling states seem to function differently in the creative process.
2. **Access to affect-laden thoughts, images, and fantasy.** This is the ability to think about ideas, images, memories, and fantasies that include affect. Thoughts involving affect themes such as aggression, sex, affection, or anxiety illustrate this blending of affect and cognition. The psychoanalytic concept of primary process thinking, to be discussed in a later section, is an example of this type of affective process.
3. **Affective pleasure in challenge.** This process involves the excitement and tension that comes with identifying a problem or mystery and wanting to immerse oneself in the task. A combination of positive and negative affect could be involved.
4. **Affective pleasure in problem solving.** This is the tendency to take a deep pleasure in solving a problem or completing an artistic production.
5. **Cognitive integration and modulation of affect.** This is the ability to control, think about, and regulate the affective events one experiences and not be swept away. Although this process is probably more cognitive than affective, it warrants inclusion because it involves both cognition and affect and it is important in the creative process.

Three other types of affect systems important in creativity are often referred to as broad motivational systems. The whole area of motivation subsumes needs, drives, and affective processes. Drive refers to both primary and acquired drives. Three major motivational systems that have been found to be important to creativity and that include affective components are intrinsic motivation, curiosity, and conflict-resolution and self-expression.

6. **Intrinsic motivation.** This is the motivation that comes from within the individual to perform a task rather than coming from sources external to the individual, such as rewards or evaluation. Amabile has carried out a research program that has found intrinsic motivation to be especially important in creativity. Positive affect is an important part of intrinsic motivation, as Amabile and Hennessy have pointed out.
7. **Curiosity.** Curiosity is a motivational state found to be important in creativity. Berlyne has written extensively on this issue. He wrote in 1966 about his view of curiosity as reflecting the organism's striving to maintain an optimal level of arousal.
8. **Conflict-resolution and self-expression.** This is the motivation that comes from the need to resolve an internal conflict or distress or to express intense emotions. In the case of conflict-resolution, a psychoanalytic concept, the individual expresses emotion through creative outlets in an attempt to resolve the problem. Sublimation occurs if the personal conflict is channeled into a specific creative endeavor and is transformed into a more universal issue. In the case of self-expression, there are many anecdotal accounts of individuals using the arts as a form of therapy to deal with emotional problems or daily stresses.

These different affective processes and motivational states work in different ways in different areas of creativity and for different types of creativity tasks. As a field, we are just beginning to learn about the role of these processes.

Theories of Affect and Creativity

Different theories of affect and creativity focus on different types of affective processes and different types of creativity. There is no one comprehensive theory that accounts for all variables and all research findings.

Psychoanalytic Theory

Historically, the first theory of affect and creativity was psychoanalytic. The key concept in the area of psychoanalytic theory and creativity is primary process thinking.

Primary Process Thinking

Sigmund Freud in 1915 first conceptualized primary process thought as an early, primitive system of thought that was drive laden and not subject to rules of logic or oriented to reality. A good example of primary process thinking is the kind of thinking that occurs in dreams. Dreams are illogical, are not oriented to rules of time and space, and frequently include affect-laden content and images. Affect is a major component of primary process thinking. The content of primary process thought is frequently affect-laden content, such as sexual images or aggressive ideation. In children, affect-laden, primary process thinking frequently includes oral (good ice cream), oral aggression (biting Dracula), and aggression (fighting; bickering).

Access to primary process thought has been hypothesized to relate to creative thinking for several reasons. First, because associations are fluid and primitive images and ideas can be accessed and used, there is a wide range of associations to be used in creative work. According to classic psychoanalytic theory, primary process thinking is characterized by mobility of cathexis—that is, the energy behind ideas and images is easily displaced. In this mode of thinking, ideas are easily interchangeable and attention is widely and flexibly distributed. Therefore, access to primary process thinking should facilitate a fluidity of thought and flexibility of search among all ideas and associations. Flexibility and fluidity of thought are characteristic of two of the most important cognitive processes involved in creative thinking. Second, the affective component of primary process thinking should also be facilitative of creative thinking. Individuals who are comfortable with affective ideation should have a wider range of associations. In Freudian terms, they would be less “repressed” and be comfortable thinking about a wide range of affective content. This ability would be especially helpful in artistic expression in the arts. In the arts, especially the narrative arts, it is helpful to remember past events that include complex and uncomfortable emotions.

Divergent thinking and transformation abilities are the major processes that are unique to the creative process. Divergent thinking refers to the ability to generate a variety of associations to a word or solutions to a problem. A typical item on a divergent thinking test would be “How many uses for a brick can you think of?” A high scorer on this test would generate a high number of different, acceptable uses for the object. Individuals who can use primary process and the fluidity of thought and breadth of associations inherent in it should be highly divergent thinkers. They should also score high on a second important cognitive process, transformation ability. This involves the ability to transform or revise what one knows into new patterns or configurations and to be flexible and break out of an old set. Again, the broad associations and flexible thinking characteristic of primary process should facilitate transformation abilities.

Regression in the service of the ego. An important point in psychoanalytic theory is that it is controlled access to primary process thinking that is facilitative of creative thought. The concept of regression in the service of the ego postulates that creative individuals could regress in a controlled fashion and tap into primary process thinking. The creative individual could go back and forth between early, primitive primary process thought and more mature, rational, secondary process thinking. The creative individual could be distinguished from the individual with a thought disorder in that the creative individual was in charge of this regressive process and could critically and logically evaluate the loose, primitive associations and images.

A number of theorists have proposed that the concept of regression may not be necessary in understanding the relationship between primary process and creativity. Rather, we can think of primary process as a separate cognitive-affective process that one can have access to that then facilitates divergent thinking and transformation abilities. A separate ability to cognitively integrate and modulate primary process thinking would be important in the critical evaluation stage of creative thought. The ability to switch between affect-laden primary process thinking and logical critical thinking is associated with creativity.

In summary, the psychoanalytic model of primary process and regression in the service of the ego stresses the importance of two types of affective processes in creativity: a) access to affect-laden thoughts and images and b) cognitive integration of affective material. These processes are important in the facilitation of creative cognitive processes.

Empirical Evidence

Primary process has been found to relate to creative processes in the research literature. Most of the research has used the Rorschach inkblot test as a measure of primary process. In general, as psychoanalytic theory predicted, the ability to give good responses to the Rorschach that contained primary process content was significantly related to measures of divergent thinking and flexibility in problem solving. Using a different approach, good artists were found to have more primitive primary process content than poor artists and top ranked creative architects had more libidinal (sexual) primary process content than lower ranked architects.

Similar results have been found with children, although age, gender, and specific scores emerge as important factors. Primary process on the Rorschach significantly related to divergent thinking and to flexibility in problem solving for boys, but not for girls, independent of intelligence. These gender differences occur throughout the research literature with adults and with children. For children, much of the primary process responses on the Rorschach have affect themes in the percepts. Typical responses in children are bloody bears, scary monster, or yukky spider.

In summary, affect-laden primary process thinking is related to cognitive processes important to creativity for males. For females, the results are mixed. A few studies found that pure access to primary process was related to creativity in females. One possible explanation for these sex differences is that females do not have as much access to primary process thought because of cultural taboos and socialization processes. Another explanation could be that the Rorschach is a more valid measure of primary process for males than for females. Indeed, when measuring primary process in children’s play, Russ found that primary process related to divergent thinking for both boys and girls. There are many questions remaining to be answered in this research area.

Conflict-Resolution and Self-Expression

From a different perspective, psychoanalytic theory has stressed the importance of unresolved conflicts and unfulfilled wishes in motivating the individual to engage in creative work. For example, unrequited love will be expressed in a poem or drawing. Resolving the loss of a loved one will occur as a result of composing a song. The motivating force of transforming one’s own pain into artistic creations that have universal appeal is thought to be an important factor in creative work. Although there is little direct empirical evidence for this theory, there is indirect evidence from clinical vignettes from therapists and from descriptions from creative individuals. In addition, Pennebaker’s research found that expressive writing can have beneficial effects on mental and physical health.

Mood and Creativity

Research has investigated very specifically how affect influences cognitive processes important in creativity. Much of the research within this framework has used a mood induction paradigm. A specific mood state is induced by having participants watch a film, receive a gift, or think about a memory that is happy or sad. Mood induction provides a way of altering affect states so that the effect on cognitive processes can be observed.

A growing body of research has found that induced affect facilitates creative thinking. [Alice Isen \(1987\)](#) has carried out a series of important, carefully controlled studies in the mood induction area. She and her colleagues found that positive affect induction resulted in more creative problem solving when compared to control groups. Other researchers found similar results with a variety of creativity measures. Isen concluded that the underlying mechanism is that positive affect cues positive memories and a large amount of cognitive and affective content. This process results in defocused attention and a more complex cognitive context. This, in turn, results in a greater range of associations and interpretations.

What about negative affect? In general, induced negative affect has had no effect on creative problem solving. As the researchers pointed out, it is possible that the negative affect that was aroused (for example, by a film of the Holocaust) was too extreme, and that less extreme conditions of negative affect should be explored. A few studies suggest that milder forms of negative affect could facilitate some kinds of problem solving tasks. Different types of affect may have different effects on various dimensions of problem solving ([Kaufmann and Vosburg, 2002](#)).

In a recent meta-analysis of 25 years of mood-creativity research, [Baas, de Dreu, and Nijstad, \(2008\)](#) concluded that a number of variables are involved in this complex area of mood and creativity. Specific mood types (not just positive and negative) and aspects of those moods must be considered. They concluded that positive moods do produce more creativity than neutral moods. But this is true for positive moods like happiness that are activating and associated with approach motivation. It is not true for positive but deactivating mood states like relaxation. They point out that an interesting practical implication of this finding is that relaxing in a bathtub or on the beach may not be conducive to creative thinking. How the task is framed is also important. Positive moods lead to more creativity when the task is framed as enjoyable and intrinsically rewarding and to less creativity when the task is framed as serious and extrinsically rewarding. As for negative affect, in general, deactivating negative mood states like sadness were not associated with creativity, but activating mood states of anger, and in some situations, fear, were facilitative. Baas in [2019](#) concluded that valence, activation, and motivation activation are all involved in determining mood effects on creativity.

Intrinsic Motivation

Intrinsic motivation is conducive to creativity. Intrinsic motivation is defined as having to do with the intrinsic value of attaining a creative solution. Research has found that conditions extrinsic to the task, such as reward, evaluation, being watched, and restricted choice, all have detrimental effects on creativity. Intrinsic motivation is important for task persistence, for seeing a project through, and for ensuring exploration of solutions.

Intrinsic motivation is also accompanied by positive affect. The love of the task is an important component of creative work. Love of the work has been mentioned as crucial by most creative individuals. More research is necessary to explore the positive affect and intrinsic motivation link.

Tension and Creativity

Tension as an important factor in creativity has been conceptualized by Mark [Runco \(1994\)](#). He presented a variety of ways in which tension could be involved in the creative process. The anticipation of the resolution of tension could be an important motivating force in creative problem solving. The tension could be an internal conflict, similar to psychoanalytic theory's idea of conflict-resolution. For example, several researchers have found that creative individuals have come from families with problems or have themselves felt marginalized in the society. Tension could also develop from identifying a problem or sensing a gap in an area. Problem identification is important in creativity. Creative individuals could use the tension experienced in seeing the problem as both a cue and a motivator. Tension can also be conceptualized as an activation mood, as discussed above.

Affective pleasure in challenge could also be part of this process. There could be a mix of negative (tension) and positive affect in identifying a problem. The anticipation of the positive affect involved in solving the problem may act as a motivating force. However, there may be an inherent excitement in seeing the ambiguity in the situation that leads to problem identification, which is itself pleasurable. It may be similar to the pleasure that some children feel in discovering "What is wrong with this picture?"

The concept of optimal challenge is relevant here. An optimal amount of challenge is necessary for the experience of flow to occur. Flow is a total involvement in the activity, a deep sense of enjoyment, and optimal challenge. Creative activities involve this sense of flow. Perhaps optimal challenge involves the best mix of tension in seeing the problem and the anticipated pleasure of the creative act.

Curiosity

Although it is not clear whether or not curiosity has affective components beyond arousal, it is a motivational system important in creativity. Curiosity may be viewed as reflecting the organism's efforts to maintain an optimal level of arousal. Subjective feelings of

pleasantness have been associated with the growth of the curiosity drive as a function of increasing stimulus intensity and arousal of the positive reward system. Curiosity may interact with anxiety to determine approach or avoidance behavior.

Curiosity is important to creativity because interest in novelty and exploration aids in problem identification as well as task persistence. Also, the highly curious and risk-taking individual is more likely to gain a wide variety of experience that would add to his or her knowledge base.

Integrative Models of Affect and Creativity

Integrative models of affect and creativity identified the connections among affect, cognitive, and personality processes important to the creative process.

In the 1993 Russ model of affect and creativity, the major cognitive abilities that emerge as unique to and important in the creative process are linked to related specific affective processes and to global personality traits. In some cases, the personality traits are behavioral reflections of the underlying affective processes. One assumption of this model is that these specific affective processes and personality traits facilitate creative cognitive abilities. Reciprocal interactions probably occur as well.

Because there is no one comprehensive theory of affect and creativity, a variety of theories and underlying mechanisms are represented in this model. At this time, it appears that different mechanisms underlie different components of the creative processes. For example, access to affect themes and affect states facilitates a breadth of associations. Intrinsic motivation should help the individual keep on task and explore alternative solutions. Good cognitive integration of affect should aid the critical thinking process necessary in the evaluation stage of creative work. An important point is that in any creative act, different processes and different mechanisms could be involved.

Ivcevic and Hoffman (2019) present a comprehensive model of creativity and emotions. They focus on emotion-related personality traits and emotion abilities such as the ability to manage emotions and to use emotions in creative thinking.

Play, Affect, and Creativity

Play is important in the development of many of the cognitive, affective, and personality processes important in creativity. The type of play most important to the area of creativity is pretend play. Pretend play involves make-believe, the use of fantasy, and treating one thing as if it were something else. Pretend play frequently involves affect. Children express both positive and negative emotion in play. In 1987, Fein proposed that the affect is represented in an affective symbol system. Information about affect-laden events and relationships is coded and stored in these symbols. These symbols are reflected in pretend play and are especially important for creative thinking. From a psychoanalytic perspective, play is a place where primary process thinking as well as other kinds of affect can be expressed.

Research Evidence

Research supports a relationship between affect in play and creative thinking that is independent of intelligence. A positive relationship has been found between playfulness (that included the affective components of spontaneity and joy) and divergent thinking in kindergarten children. Similarly, a relationship has been found between the amount of affect expressed in play and divergent thinking in several samples of first and second graders and in preschool children as well. In a longitudinal study, affect in play in young children predicted affect in play stories in older children. This longitudinal study suggests that affect in fantasy is a trait that has some stability over a four year period.

It is important to note that both positive and negative affect in play relate to creativity. In play, negative affect is well-controlled in most children and is pretend, after all. The negative affect is not intense and is often enjoyable to the child.

Affect in play has also been found to be associated with affect in memories. Having access to emotional memories could also be an advantage in creative production.

Play has been found to facilitate creativity in children, but there is no conclusive evidence that it is the affect expression in play that is the causative factor. That question continues to be investigated.

Affect, Creativity, Adjustment, and Psychopathology

Research has found that creativity relates to both adjustment and psychopathology. How can both findings be true? If we conceptualize creativity as evolving from a configuration of cognitive, affective, and personality processes that set the stage for creative acts to occur, then the propensity for adjustment could go either way depending upon the mix of processes. If creative individuals are good divergent thinkers, have diverse associations, have access to primary process in a controlled fashion, are open to affect states, and are good critical thinkers, then one would expect them to be sensitive but relatively stable individuals, perhaps with periods of emotional instability. Some research studies are supportive of the hypothesis that creative individuals are adaptive and well-adjusted. Many of the psychological traits that are related to creativity are also indicators of positive mental health.

Other researchers have found a relationship between creativity and psychopathology. In a study of British artists and writers, 38% of the sample sought treatment for mood disorders. [Ruth Richards \(1993\)](#), based on her research, offered three major conclusions about creativity and mental health. She concluded a) mild psychopathology may contribute to creativity (mild mood swings especially may carry advantages for creativity), b) intermediate levels of variables may be most optimal for creativity, and c) affect is important in creativity. She stressed the importance of positive affect for creative accomplishment.

Artistic and Scientific Creativity

Affective processes play different roles in different domains of creativity. In general, scientists have been found to be better adjusted than artists. A higher than normal proportion of artists have been found to have mood disorders. Research with scientists paints a different picture. A number of researchers have concluded that creative scientists may be a more emotionally stable group than creative artists. Why would this be so? The personality differences between creative artists and scientists may reflect the differences in the domains of creativity and the cognitive and affective processes that are involved. There are similarities. Divergent thinking is important in scientific problem solving as well as in artistic production. Breaking out of a set and creating new configurations are also important in both types of creativity. Affective process would be expected to function in similar ways for similar creative tasks in artists and scientists.

One of the main differences between artistic and scientific creativity may be the importance of getting more deeply into affect states and thematic material in artistic creativity. This in-depth involvement in the affective processes themselves may not be as necessary in scientific problem solving. Some theorists think that artists incorporate early traumas and conflicts into their artistic productions. Scientists do not usually have to face into and incorporate affect-laden material into their scientific problem solving. For the scientist, good divergent thinking ability, transformation ability, and a flexible cognitive style may be sufficient for creative work to occur. For the writer, the musician, or the artist, the need to get to basic and deep emotions, primary process material, and affect-laden memories and images may be necessary in order to be able to express universal truths that transcend the individual and speak to others.

One often hears artists and writers describe the need to have this kind of experience. One can see how the need to live in that emotional state and to control that process may at times be disruptive, resulting in emotional instability and some personal agony. Writers in particular describe anxiety at uncovering primary process material.

On the other hand, interviews with creative scientists indicate that scientists often feel very strong emotions during the creative process. In a study that gave artistic and scientific problems to art and science students and had them rate their intensity of emotions, art and science students experienced the same intensity of affect before and during insight, but art students reported more positive emotion after insight than did science students.

It is logical to assume that each specific artistic and scientific domain will have cognitive and affective processes that are especially important in that area. Different creative profiles should emerge for different fields. A dynamic (not static) mode of affective-cognitive interaction has been proposed for artistic creativity. Creativity and psychopathology are ever changing continua with a mixture of affect states. Only a dynamic model can capture the complexities of the interactions.

Neurological Processes, Affect, and Creativity

As research on affect and neurological processes becomes more sophisticated, neuroscientists are learning about the interaction between affect and cognition. With the development of the CAT scan, PET technology, and fMRI technology, researchers can map cerebral activity and obtain a picture of brain involvement during problem solving. Eventually, images may map the actual neurological processes involved in creative problem solving.

Research by Klaus Hoppe showed that the mutual interaction of the left and right hemisphere is important in creativity. The corpus callosum is involved in exchanging information between the hemispheres. The symbolization and visual imagery in the right hemisphere is available to the left hemisphere in creative functioning. Cognitive representation of emotion occurs in both hemispheres.

Research on the neurological processes involved in affect processes has addressed several important questions in the area of emotion that have implications for the affect and creativity area. It has been concluded that different emotions have different neurological and physiological activity. It appears there are different brain systems that mediate different emotions. Therefore, researchers need to investigate specific emotions. This conclusion is consistent with the findings in the affect and creativity area that different emotions have different effects on cognitive processes.

It has also been proposed that different emotions are represented in memory. An important point is that these emotions appear to be stored in the amygdala. This is a different area of the brain than that which stores non-emotional memories, the hippocampus. Research suggests that emotional memories are organized differently than are non-emotional memories. The emotional memory can act independently of the cognitive system. It has been suggested that these precognitive emotions are functional in infants during the early formative years. Behavior is affected, but the individual has no conscious memory of the event.

The concept of emotional memories functioning as a separate system is consistent with some theoretical explanations about why affect should facilitate creativity. If affect stirs a network of associations and emotion-laden memories, which in turn affects cognitive processes, then the organizational system of those emotional memories becomes very important. The rules that govern how this

emotional memory system functions still await discovery. These principles should help understanding of the mechanisms that underlie the complex relationship between affect and creativity.

Conclusion

During the past 30 years, there has been a resurgence of research in the affect and creativity area. As it should be in any science, the research is theory driven; theories are being developed and tested, measures and methods are being refined, and new lines of investigation are opening. The field is interdisciplinary and what is learned in one field informs another. For example, knowledge about affective processes from neurophysiological research will be applied to affect and creativity research. Key concerns for the future in the affect and creativity area are a) identifying specific affective processes that are most important for creativity tasks; b) discovering the underlying mechanisms that account for the relationships between affect and creativity; c) exploring differential effects of various types of affect, such as positive or negative affect, on creativity; d) understanding how affect and creativity relate to psychological adjustment and psychopathology; and e) understanding the developmental processes involved in affect and creativity. As research paradigms and measures of affect continue to be developed, researchers will continue to learn about this exciting area.

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Engineering: The Ultimate Expression of Creativity?

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Introduction

Plumbers solve plumbing problems; Accountants solve financial problems; Doctors solve medical problems—and Engineers solve technological problems. The point of this is that most professions can be described succinctly as exercises in generating solutions to problems. In many cases, the solutions represent the reapplication of some tried and tested concept. For example, each morning as we secure our shoes to our feet, we do not need to reinvent shoelaces. These simple bits of string serve their purpose, and are a satisfactory solution to the underlying problem.

However, in many cases, the tried and tested solution is not enough. What if cotton, or nylon, were no longer available; or perhaps Government imposed a heavy tariff on these materials? Would our conventional shoelace still be a viable solution to the problem? What happens when the plumber encounters, for example, a house that draws water from a private well instead of from a municipal water supply? How does a doctor diagnose a patient who is too young to describe their symptoms?

Each of the preceding examples represents the impact of *change* on an otherwise routine problem solving process. Change brings with it one of two requirements. Either, the solution must be an *incremental improvement* on what already exists—it must be better, or faster, or cheaper—or, it must be a *wholly new* concept—a paradigm shift, in other words.

Take the case of climate change, and in particular, the problem of carbon added to the atmosphere as a result of coal-fired power generation. The *change* to the climate means that the solution to energy generation—burning coal—is no longer a viable, or sustainable, solution. It's true that one possible solution is to continue to burn coal. However, as Albert Einstein warned, doing the same thing over and over again, and expecting a different result, is insanity (and self-evidently, will not reduce carbon in the atmosphere). This means that only two realistic solution pathways exist. Either, make incremental improvements to the existing solution, for example by making coal-fired power generation *cleaner*, or, find a wholly new approach to the problem of power generation, such as solar-thermal or wind-powered electricity generation. The former—clean coal—is an incremental approach to an existing problem, while the latter is a completely new, or radical, approach.

Because *change* is such a ubiquitous, perhaps even defining, characteristic of life on this planet, it is no surprise that a key feature of most professions—not least engineering—is the ability to generate both incrementally, and radically, *new* solutions. In other words, a key concern of engineering is the generation of new and effective solutions to problems—that is, *creativity*!

Engineering and the Psychology of Creativity

A strong case can be made (e.g. Cropley, 2015) that it was engineering that served as the catalyst for the modern interest in creativity. The *Sputnik Shock* of October 1957 – the launch of the world's first artificial satellite—galvanised the United States and other Western nations, and for the first time linked technology and creativity together. How was it possible for the Soviet Union to beat the United States in the first major event of the Space Race? As the United States grappled with this fact, creativity was offered as one explanation for the success of the Soviet Union's satellite technology. What this meant was that for the first time, a *psychological*, qualitative explanation was put forward to explain a technological, quantitative achievement. Western thinkers attempted to explain the Soviet breakthrough not just in terms of resources and technology, but in terms of *who* developed the new technology, *how* and *why* they developed it, and *where* the development of the technology took place. The Soviet achievement in space, rightly or wrongly, was attributed to superior *engineering creativity*! Fortunately, the means to explore this hypothesis further had been set in motion by Guilford (1950), and his early work on the psychological concept of creativity.

In fact, throughout human history, people have been developing technological solutions to problems stemming from basic driving *needs* (in the sense of Maslow, 1943: for food, warmth, shelter, security, and so forth) and problems stemming from *change* (to their environment, and to their resources). The need to develop more efficient ways of providing food led to the development of the pre-historic hand axe. The need to propel watercraft more efficiently led to the development of the oar. The need to spin natural fibres into thread and yarn, in order to make cloth, led to the development of the spinning wheel (see Crompton, 2019 for a full discussion of the history of technological creativity). The psychological capacity to generate and exploit novel, effective solutions to technological problems—*engineering creativity*, in other words—has been an abiding strength of the human species for thousands of years.

Engineering Design: Creativity

The *process* of generating new and effective solutions to problems, if not the broader psychological elements, has long been understood as central to engineering. Indeed, "... if more than one solution exists, and if deciding on a suitable path demands ... making choices, performing tests, iterating, and evaluating, then the activity is most certainly design" (Horenstein, 2002, p. 23). There is, therefore, a remarkable similarity between what Guilford (1959) identified as the key stages of creative problem solving—problem recognition, idea generation, idea evaluation, and solution validation—and the key steps of engineering design.

The core elements of this creative, design process hinge on two forms of thinking. On the one hand, the ability to recognise that a problem exists, and to express it concisely and accurately, requires the ability to think *convergently*. The ability to apply logic and analysis in order to find the *right* answer is critical. Similarly, the ability to evaluate the relative merits of a range of possible solutions, usually against a set of constraints, is a convergent process. Even once a particular possible solution has been selected, verifying that it does, indeed, satisfy the underlying problem remains a process of logic, analysis, evaluation and judgement.

Where engineering design has frequently lagged behind creativity, however, is the key stage involving the generation of the *possible* solutions. This *divergent* thinking stage, almost synonymous with the modern concepts of creativity, requires unconventionality, an ability to shift perspective, and a capacity to introduce new, often surprising, ideas. Without divergent thinking, neither creativity, nor engineering design is capable of responding to needs and to change with incrementally and radically new solutions.

In many ways, therefore, engineering design is the ultimate expression of creativity. For thousands of years humankind has depended on its ability to recognise problems, generate a diverse range of ideas for solving those problems, and the ability to evaluate and implement these ideas as practical solutions. This would seem to suggest that humankind, in the process of engineering design, has reached a pinnacle of creativity.

Notwithstanding considerable evidence to support such a claim—modern farming technologies that feed billions; modern medical technologies that have cured diseases, and; modern communications technologies that connect people across the globe—there remains enormous scope for improvement. The engineering profession remains one that is seen principally in terms of the application of critical thinking skills, and the laws of nature, to the efficient use of raw materials. Engineering design is seen more as a matter of reapplying the *known*, rather than as a question of exploring the *new*.

Engineering design is a good representation of creativity, but it is not yet the *optimal* representation of creativity. Not only are there weaknesses in parts of the *process*, in particular the application of divergent thinking, but there are also opportunities to improve engineering design by drawing on the considerable body of knowledge available from some 70 years of, largely psychological, creativity research. To move towards this optimisation of engineering design as an expression of creativity, at least five questions need to be addressed. These hark back to the turmoil surrounding the Sputnik Shock, and the search for a qualitative answer to that event. These questions are:

- *Who are the creative engineers?* What aspects of motivation, personality and affect define the creative engineer? Are these essentially the same as creativity in any domain?
- *How do creative engineers think?* Exactly how do engineers make use of convergent and divergent thinking? What does each type of thinking contribute to the design process?
- *What is a creative engineering environment?* What factors in a typical engineering workplace can help or hinder creativity? How best is the ideal engineering design environment created?
- *How do we recognise creative artefacts?* What characteristics define a creative product? Is creativity more than just novelty? What value is added by creativity in a solution?
- *How should creative engineers be educated?* Is engineering education teaching things right? Is engineering education teaching the right things? How can engineering education be rebalanced for optimal creativity? What is the impact of the future of work on engineering education?

Key Concerns for Creativity in Engineering

As the United States, in particular, responded to events in the Space Race during the late 1950s and early 1960s, it looked as though engineering was entering a Golden Age. Massive investments in STEM education, and Kennedy's challenge of landing humans on the Moon, coupled with a new, cross-disciplinary interest in the psychology of creativity, seemed to herald an era in which engineering design would incorporate, on an equal footing, all of the elements that are a necessary part of Guilford's

(1959) stages of problem solving. Buhl (1960) is a particularly good example of how this cross-disciplinary thinking was developing during this period.

That these questions are still being raised in the 21st century may be partly a result of success of the United States in the Space Race. Only 12 years after the Sputnik Shock, the US succeeded in landing humans on the Moon, and the panic of 1957 had subsided. Perhaps all that was required, after all, was *quantity*? With more engineers, more resources, and more money, any technological problem could be solved with a kind of quantitative *brute force*. And yet, as the world moves rapidly into the era of Industry 4.0, big data, artificial intelligence, and cyber-physical systems, attention is turning, once again, to qualitative questions of engineering, design and the future of work. The following sections summarise five questions that have always demanded answers, if engineering design is to fulfil its potential. However, in the current era of digital transformation, these questions may be more important than ever before.

Who Are Creative Engineers?

For some 70 years, psychologists have examined the facets of personality and qualities of the individual that link to creativity. Even though one of the abiding debates in creativity research concerns domain-general and domain-specificity—is creativity a general characteristic or quality, or is it unique to different domains—there seems to be wide agreement that Openness to Experience (in the sense of personality) is characteristic of all creative individuals, and therefore engineers. Conscientiousness also features prominently as a strength of creative individuals in domains that lie towards the scientific end of the Art versus Science continuum.

In addition to high levels of openness and conscientiousness, creative engineers would also be expected to be goal-directed, willing to ask questions and to take risks. Furthermore, in terms of affect—feelings and emotions—creative individuals, including engineers, would be expected to show flexibility, curiosity, tolerance of uncertainty and independence.

On the one hand, it seems possible, based on extant research, to formulate a fairly clear answer to the question *who are creative engineers*. At the same time, domain-based studies frequently use categories—Art and Science, for example—that do not do justice to the nuances *within* the domain.

Even within a domain such as *science*, there are large differences between, for example, engineering and industrial design. Both are concerned with the development of artefacts, and both are broadly technological in nature. Both seek to satisfy needs typically expressed by end-users, and yet engineering can be said to approach such problems from the *inside out*, while industrial design works from the *outside in*. Cropley and Kaufman (2019) examined differences between these two groups in order to expose more subtle *within-domain* differences. If engineering design, as an expression of creative problem solving, is to be optimised, then a deeper, and more domain-specific, understanding of personality, motivation and affect is needed. Is engineering design attracting people with the right dispositions, and is the domain shaping these dispositions in a way that maximises the opportunity for creativity? Is one general disposition right for engineering design, or is the key the ability to switch back and forth, much like the creative problem solver must switch between convergent and divergent thinking as the process unfolds?

How Do Creative Engineers Think?

Guilford's (1959) model of the creative problem solving stages is noteworthy, in particular, for how it identifies the two key cognitive processes: convergent and divergent thinking. The former is defined by logic, analysis, and the ability to find a single, correct, solution. Divergent thinking, in contrast, is characterised as a process of generating many possible solutions, without regard to constraints such as correctness. Each is necessary, but not sufficient, for the overall problem solving process. Almost by tradition, it is assumed that engineering is largely concerned with convergent, critical thinking.

Discussions of engineering do, in fact, identify a generative, divergent stage as central to design. Despite this, it is rare to find discussions of engineering design drawing on the psychological literature of divergent thinking to optimise this part of design. An explanation for this disconnect may lie in how psychologists have defined, and measured, divergent thinking.

In traditional, psychological discussions of divergent thinking, this cognitive process is typically measured by presenting an individual with an object—a brick, for example—and inviting the individual to respond with as many *alternate uses* as possible for that object. Divergent thinking is measured in terms of the volume and nature of the alternate uses generated. Cropley et al. (2017), however, noted that this *form-first* approach to divergent thinking—presenting a *solution* (a brick) and asking for as many *problems* as possible (how to build a house, how to hammer in a nail, etc) – while undoubtedly divergent, is not how engineers work or think! They suggested that a realistic form of divergent thinking, at least for engineers, is *function-first* in nature. In this case, the stimulus is a *problem*—e.g. how to build a house—and the responses are a variety of possible solutions—e.g. bricks, rocks, wood, etc. It may be that when engineers search for help to optimise the creative design process, and find the key stage of idea generation characterised as a form-first process, they ignore this as irrelevant to their needs and look elsewhere for help.

Like any creative, problem solving, process engineers think in two ways. They must think convergently in order to identify and refine the problem to be solved. In engineering, good practice is to express this problem in just four words—*how to verb noun*—where the verb and the noun are expressed in as abstract a form as possible, so as not to constrain possible solutions. Equipped with a well-defined (and function-first) problem statement, engineers must then switch to a divergent thinking style to generate possible solutions, without regard to quality or feasibility. Once this pool of possible solutions has been developed, logic, reason and analysis return with a convergent evaluation of the possible solutions. Now they must be evaluated for feasibility. Do they fit the constraints

of the problem? Finally, once the best solution has been selected, it must be implemented and evaluated. The final convergent question in a process of engineering design is *validation*. Does the solution do what it is supposed to do?

What Is a Creative Engineering Environment?

Engineers typically work in teams, such is the nature, scale, and the complexity of modern design and implementation processes in technology. Inevitably, therefore, the individuals (who) and the processes (how) intersect with an environment (where).

In fact, there has long been some recognition of this interplay between person, process and environment in engineering design. Defence and aerospace company Lockheed Martin created their famous *Skunk Works* in 1943 specifically to facilitate innovation through small, empowered teams. Founder Clarence “Kelly” Johnson sought to create an unconventional physical and organisational environment that removed bureaucratic barriers, defining 14 *rules and practices* of Skunk Works. These enshrined a simpler process, using small teams with high levels of authority and freedom, as well as a more flexible system of rewards.

In the 21st century, the psychology of creativity can explain why the Skunk Works environment is necessary for optimising engineering design. Cropley (2016) described this in a more generalised fashion. As the engineering design, creative problem solving process unfolds, it is governed by a series of either convergent or divergent stages. Individuals engaged in this process are shaped by their individual dispositions, feelings and motivations. Each stage, in addition, may be facilitated, or constrained by general environmental conditions. In this way, each stage of engineering design, to be optimised, requires the right set of individual dispositions and qualities, coupled with the right environmental conditions for the particular convergent or divergent stage in question. If any of these three are misaligned—for example, an unmotivated, closed individual in a divergent thinking process, or, a highly motivated, highly divergent team, with no time or resources to generate ideas—then engineering design, and creativity, will be blocked.

Where many modern engineering organisations struggle, in the engineering design process, is with a lack of organisational, cultural flexibility. In an organisational context, engineering design is a matter of aligning people, processes and culture. Most engineering organisation have a natural, or default, combination of these factors. Sometimes these naturally align with the conditions that are ideal for design and creativity, but often there is a mismatch. For many engineering organisations, this default combination favours problem recognition, idea evaluation and solution validation, but blocks idea generation. These organisations are good at implementing a solution once they have it, but struggle (and often *know* they struggle) in getting the good solution in the first place. The pathway for optimising engineering design, for these firms, lies in developing their agility—their ability to recognise each stage of the process as they are in it, and to tune their environment and people to suit.

How Do We Recognise Creative Artefacts?

The purpose of engineering design, and creativity, is to generate solutions. Processes, employed by individuals, in organisations lead to the generation of a variety of solutions of a broadly technological nature. Two issues, however, have limited engineering design creativity. What *are* solutions, and what does a creative solution *look like*?

Solutions to engineering problems can take one of four broad forms. *Artefacts* describe tangible objects such as cell phones and chairs—more broadly, hardware—that can be touched and observed. *Processes* describe activities or tasks, possibly executed by people, which achieve an outcome. *Systems* describe more complex combinations of hardware, software, and people that satisfy defined needs. *Services*, finally, describe usually intangible systems of labour and/or material aids that achieve some outcome.

Even with the range of solution types defined, many engineering organisations still struggle with the fundamental question of what does a creative solution look like? What properties or characteristics define creativity in a solution, and what value do they add?

There is good agreement in the creativity research literature regarding two key qualities of a creative solution. Novelty is a prerequisite. If a solution is not new, original, and surprising, then it cannot be regarded as creative. A creative solution must also be appropriate to the task, or problem, in question. Cropley and Cropley (2005) first discussed these properties of a creative solution in an engineering context, reaffirming that *novelty* and *effectiveness* must be present in a *creative* solution. Extending this discussing specific to the engineering domain, they also explained that *elegance*—in simple terms, how well executed a solution is—and *genesis* (the extent to which a solution changes the paradigm) also add to the creativity of a solution.

The value of effectiveness almost needs no explanation. A solution that is ineffective is, in fact, no solution at all. A solution that adds novelty to effectiveness moves a solution from the status of *an existing solution to an existing problem*, to a new solution to an existing problem. This incremental creativity—doing something better, or faster, or cheaper—injects the newness that is vital as a response to change. An elegant solution—one that is well-executed—is usually also a more effective solution therefore enhancing the overall creativity of the solution. Finally, when a solution possesses genesis we often find solutions that have redefined the problem. A solution with genesis is not just an existing solution that is improved, but is a wholly new concept. Incremental solutions have a finite life, governed by the law of diminishing returns. Genesis is the means for defeating the law of diminishing returns, by introducing wholly new concepts.

How Should Creative Engineers Be Educated?

Despite the centrality of design to engineering, and therefore the importance of creativity as a part of engineering, there remain many opportunities to align this creativity with engineering. The discipline of engineering has demonstrated many great

achievements in creative problem solving over many centuries. And yet, there remain many areas ripe for optimisation through a greater understanding of the psychology of creativity amongst engineers.

One particular area of engineering that is overdue for innovation is education. Many institutions, and many professional bodies, have paid lip service to creativity over many years, with little real change to curricula. Cropley (2017) has discussed the problems, and possible solutions, in greater detail. A long-standing reductionist paradigm in engineering education has resulted, for decades, in engineering curricula whose primary focus seems to be narrow over-specialisation and an emphasis on factual, as opposed to practical, knowledge. Very little room is made for the deliberate development of skills and abilities vital for design and creative problem solving.

There is some reason for optimism, however, with a growing awareness of the necessity for creativity and complex problem solving skills in a world dominated by digital transformation, Industry 4.0 and related technologies. The psychologist Jerome Bruner (1962), in fact, warned of the coming change describing a future in which creativity would be the last bastion of human mental sovereignty. This is as true of engineering as of any activity. Engineering education must be proactive in leading the transformation of engineering to a focus on design and creativity.

Creativity in Other Domains?

The field of creativity continues to debate questions of domain-generalty/specificity (e.g. Kaufman et al., 2017). There is broad consensus, for example, that an individual, highly open to new experiences, motivated and with an appetite for risk, working in a favourable environment, and equipped with the ability to think divergently, will exhibit creativity, whether artist, thief, or engineer. Research, however, continues to explore the nature and extent of domain-specific abilities. A creative artist, for example, may also be characterised by a *lack* of conscientiousness, in contrast to a creative engineer who is high on this trait. What seems to be settled is that the domain similarities and differences remain a function of four fundamental areas: person, process, press (environment) and product.

The point is that creativity is fundamentally the same thing across domains, and that is defined by the *stages* that govern this process. *Design* is just another term for the sequence of activities that comprise creative problem solving. Whether these steps are labelled as problem definition, problem recognition, idea generation, and so forth, or simply *what are you trying to do, how will you do it, and why is this way of doing it best*, there is an underlying similarity that links all creative domains. *Artistic design*, therefore, has much in common with engineering design, and the domain specific differences may be said to exist only when we dig deep enough. *There is more that unites creativity than divides it*, to paraphrase Argentinian statesman Mauricio Macri. If engineering is the ultimate expression of creativity, it is not because it is more worthy, but simply because it served humanity so well for thousands of years.

Concluding Thoughts

When engineering design is viewed through the lens of creativity research, certain things are apparent. First, the *process* of engineering design bears a strong similarity to the more general process of creativity. However, while creativity research has articulated many of the key psychological cognitive, personal and organisational concepts, features and characteristics of this process, engineering design has largely ignored these. Instead, engineering design, and engineering more broadly, has remained defined largely in terms of key processes of logic, analysis and judgement. Despite this narrow focus, history is replete with examples of humankind's skill in developing novel, effective, elegant and frequently paradigm-breaking solutions to all manner of needs and technological problems. As the world moves into an era of Industry 4.0, our ability to continue to exercise engineering creativity is more important than ever before. If we are to meet the challenges of climate change, economic change, and social change, it is time to refocus engineering creativity—to optimise it—to ensure that humankind remains adept at responding, with technological solutions, to the constant change that surrounds us.

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Enhancement of Creativity[☆]

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Glossary

Canalization A concept from genetics and development research in which an individual's development is influenced by the environment within genetically determined boundaries.

Cognitive processes Actions taken by the human mind to detect, interpret, and manipulate information. These include attention, perception, rehearsal, and encoding, as well as higher-order thinking skills such as problem solving.

Constructivism Learning and cognitive theories that posit that knowledge is constructed, either individually or by groups.

Discretion Decisions about what to do and when to do it, and what not to do.

Functional fixedness Reliance on traditional techniques and strategies for problem solving, even when conditions surrounding problem diverge considerably from previously encountered conditions. The inability to consider alternatives when faced with problems, especially alternative uses for traditional problem-solving tools.

Information stores In the traditional model of information processing, the locations where information is stored either temporarily (working memory) or permanently (long-term memory).

Metacognition An individual's analysis of his or her own cognitive processes or, more colloquially, thinking about one's own thinking.

Rigidity Lack of flexibility in the application of cognitive processes, especially when problem solving. This inflexibility is reinforced by the effects of prior experience.

Schema Organized information found in long-term memory. Schema theory posits that more complex schema are associated with more efficient recall and information processing.

Self-efficacy Belief in one's own ability. Usually applied to a specific subject area or task, such as mathematical or reading self-efficacy.

Social constructivism Subset of constructivist learning theories that represent knowledge as being socially constructed, either

Can Creativity Be Enhanced?

In the not-so-distant past, the belief that creativity could not be enhanced was widespread. This notion about the unchanging nature of creativity could be found in academic circles as well as the media and popular press. Although perceptions have changed slightly over the past 40 years, a great deal of controversy still surrounds the nature and nurture of creativity.

The relationship between nature (inheritance) and nurture (experience) is best conceptualized as a continuum and not as an either-or proposition. Those holding a radical nativist view assume that creativity cannot be enhanced. The extreme nativist view is now rare and current consensus holds that potentials can be fulfilled and maximized, a concept referred to as canalization

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in psychology and genetics research. The situation is analogous to one's height: each of us inherits a range of reaction within which our experiences have their impact. One person might inherit a range of potential height between 5 foot 6 inches and 5 foot 9 inches, and given specific developmental experiences (e.g., exercise, vitamins), grow to 5 foot 10 inches. This idea about a range of potential also applies to psychological constructs such as creativity and intelligence. Hence, in response to the question "Can creativity be enhanced?" the best answer is yes, because potentials can be fulfilled. Efforts to enhance creativity will not expand one's in-born potentials but can ensure that potentials are maximized.

The broad range of definitions of creativity frequently confuses discussions about creative enhancement. For example, if one defines creativity as divergent thinking, and another person defines it as both divergent and convergent thinking, the associated approaches to enhancement will likely be quite different. For the purposes of this entry, we use the comprehensive definition proposed by Plucker, Beghetto, and Dow, which encompasses most definitions and conceptions of creativity: "the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context."

What Exactly Can Be Enhanced?

When an attempt is made to enhance creativity, what exactly is the focus? To answer this question, the multifaceted nature of creativity must be recognized with its cognitive, affective, attitudinal, biological, interpersonal, and environmental components. Taken both collectively and individually, these aspects of creativity suggest targets for enhancement efforts.

Recent theory and research support the inclusion of diverse components in models of creativity. Each component has separately been the subject of significant theoretical and empirical investigation, but the importance of collectively considering these aspects is reinforced by the recent predominance of systems as well as interactionist and interdisciplinary theories of creativity. That said, we begin by discussing enhancement by focusing on each of the components.

Cognitive Components

Cognitive components are by definition intellectual. They reflect information-processing models and problem solving. Models of information processing generally include cognitive processes, transfer operations, information stores, and metacognition, each of which is important to consider when attempting to foster cognitive aspects of creativity.

Certain process strategies are very useful when looking for original ideas. As a result, creative process strategies for enhancing creativity are quite numerous and include teaching people to use cognitive tactics such as lateral thinking, brainstorming, SCAMPER (substitute, combine, adapt, magnify/modify/minify, put to other uses, eliminate, reuse), analogical reasoning (e.g., synetics), and creative problem solving. Other frequently mentioned strategies include identifying and overcoming blocks to creativity, balancing the use of reflection and tinkering, encouraging playfulness, creativity imagery or visualization, utilizing multiple perspectives, questioning assumptions, and looking for patterns. Perhaps the most popular techniques of the past 50 years have involved the teaching of divergent thinking and general problem-solving tactics and heuristics.

The role of information stores has received considerably less attention during discussions of creativity than that of cognitive processes, but the role may be no less important. Expert problem solvers tend to have better working and long-term memory skills than novices, although this distinction only applies to the memorization of situated knowledge (i.e., information that can be placed into an expert's existing schema) and not tangential or random knowledge. In addition, general knowledge may be very important during the creative process, and such knowledge depends on memory and information storage. Without well-organized information stores (i.e., schemes), knowledge becomes difficult to use and recall during the creative process. Constructivist approaches to learning, in which individuals construct their own schemas based on their personal experiences, should prove especially useful when helping people learn to retain, recall, and apply knowledge during the creative process. Jean Piaget, the well-known psychologist, titled one of his monographs, *To Understand is to Invent*, implying that true understanding depends on personal constructions of knowledge. Very often it is beneficial for students to relate new information to prior knowledge (i.e., existing schema), and activities should be based on realistic problems that require application of prior knowledge and new skills. Much new work on divergent thinking and creative problem solving relies on realistic problems.

The importance of prior knowledge can, however, be easily overstated or mislead. That is because an individual or group that is immersed in a particular field of study or interest area may be reluctant to consider ideas and solutions that are uncommon, unpopular, or even antiparadigmatic within that context (or within one's personal experiences). This phenomenon is referred to as functional fixedness or rigidity. It has also been called "the cost of expertise." Whatever the label, the result is that creative contributions in a given area are often made by individuals who are not necessarily experts within that field. A case in point is the numerous early paleontologists who had primary training in the arts. When painting and drawing illustrations of dinosaurs, they realized that the existing knowledge base was quite superficial and provided inadequate answers to many important questions. Their fresh perspective allowed them to move beyond existing paradigms and field-based constraints to make creative contributions to paleontology. Other examples include experts who retain flexible strategies while maintaining their expertise in certain domains.

Although many people believe that the exponentially increasing complexity of most disciplines has led to creative contributions to these fields, it is probably an overstated belief. The ability to apply processes and use information from areas of interest other than one's own area of interest is clearly important. The tension between different areas of interest may stimulate creativity as well. When

participating in creativity enhancement exercises, people should thus be encouraged to look across fields of study and areas of knowledge for potential solutions to their problems. This act of looking beyond the established parameters to obtain a solution to a problem has popularly become known in business circles as thinking outside of the box and psychology as insight, moving beyond the problem space, or problem finding and redefinition. Other specific strategies in this area include forcing someone to assume a different viewpoint or perspective on an issue, which can be facilitated by a debate or role playing.

Experts tend to exhibit a greater degree of meta-cognition during problem solving than do novices. In this context, metacognition involves monitoring one's own cognitive processes in order to manage time effectively, assess progress accurately, and attempt problem-solving efforts efficiently. Suggested strategies for helping students develop metacognitive abilities, which tend to develop in preadolescence, include providing a variety of creative and problem-solving strategies in a low-risk, constructive environment, encouraging self-assessment of the steps taken to solve a problem, and modeling metacognitive skills. Metacognition and its benefits are not to be expected of young children.

An intriguing, recent development is the use of transcranial electrical stimulation (tES) to stimulate specific regions of the brain to enhance cognitive aspects of creativity. The research on tES is in its early stages, and questions about long-term efficacy and results of repeated use have yet to be addressed. In addition, such manipulations raise a host of medical, ethical, and social issues that are just beginning to be debated. But the initial, positive outcomes of tES research are certainly a harbinger of future enhancement efforts as our understanding of human neurology and its potential manipulation continue to expand.

Affective Components

The affective component of creativity refers to one's emotions. Affect is quite important because creative work very likely has personal meaning to the creator. In addition to fostering creativity through the creator's personal engagement with the world, efforts at understanding those creative outputs and enhancing their expression should consider creativity's vibrancy. Bleakley (2007) identified ten different aspects of creativity: progress, conservation, innovation, transgression, discipline, complexity, inspiration, serendipity, negative capability, and withdrawal. Enhancing creativity requires consideration of its multifaceted nature and offering modifications as necessary, based on the individual, the environment, and the purpose.

Furthermore, a technique used to enhance creativity should provide more than just a new strategy – it should provide a practical use for the strategy. Benefits to individuals or society should be communicated, and intrapersonal and interpersonal incentives described. Without the aid of extrinsic motivation, the creator may become unmotivated.

Care must be taken, because – in contrast to the potential of incentives – the positive relationship between intrinsic motivation and creative behavior is well documented in the theoretical and empirical literature. But the question of whether external motivation (especially when created by external evaluations) is detrimental to creativity has yet to be fully answered. E. Paul Torrance suggested that freedom from evaluation during practice with a creative strategy resulted in more proficient use of that strategy over time, but he found this to be less true with older, late elementary students than with younger students. Other researchers have called into question whether extrinsic motivation is truly detrimental to creativity, with a few theorists going so far as to say that constrain and external motivations are essential for creativity to emerge. Very likely both are potential influences, with the contribution of each varying across individuals and tasks.

Additionally, cross-cultural application of creativity evaluation must come with a caution. It is easy to fall prey to different cultures' perceived ability (or inability) to foster and appreciate creativity based on social norms and values. Substantial work has done on creativity enhancement in East Asian countries compared to Western countries, but appropriate consideration of both the theoretical generalizations and the local variations is necessary in understanding how to apply findings from other contexts. These findings can become cultural stereotypes with little explanatory or educational value.

Given the controversy surrounding external motivation, recommendations regarding evaluation and creativity should be made judiciously. One's creativity should be subject to reasonable amounts of evaluation, but only when the evaluators are trained in how to provide constructive criticism – and the creator is willing and able to receive that feedback and use it to improve their creative work.

Attitudinal Components

Over the past 20 years, researchers and theorists have increasingly appreciated and emphasized the role of attitude and motivation in creative achievement. One's belief in his or her ability to create, defined broadly, forms an important part of the psychological foundation of creative achievement. Creative self-efficacy can be fostered by providing genuine praise and feedback about a person's creativity and avoiding discouraging statements (e.g., "You can't do that, you're not creative"). But some people may be challenged by competitive statements, again stressing the value of constructing enhancement efforts on a case-by-case basis.

Although an individual's attitude can influence whether creative problem-solving skills are applied, it is important to consider if the individual has the ability to tap into these techniques. Basadur's enhancement work posits that a lack of knowledge about how to apply creative principles may hinder their application. Creativity training can be an effective solution, but it should also foster positive attitudes about creative approaches. Basadur advises that programs designed to encourage creative problem-solving may

not have the desired effects if individuals' attitudes about creativity do not become or do not remain positive. Programs which are designed to foster enhance applications of creativity should consider how attitudinal factors will be addressed (See Motivation).

The attitudinal enhancement of creativity may involve modeling, which can be accomplished in a variety of ways. Individuals can be exposed to information about unambiguously creative individuals, perhaps via biographies or case studies. These can provide a glimpse into the more personal aspects of creativity and provide evidence that even eminent creators "are just human, like you and me." This kind of information can be reassuring and even inspiring, though it does not suggest specific ways to be creative. It is informational in the literal sense, providing factual rather than procedural information about creativity. In a similar vein, teachers, managers, parents, and others who are attempting to foster creative self-efficacy in others should model a can-do, enthusiastic attitude when confronted with problems and tasks that require creative solutions. By explaining their thought process as they tackle the problem, the creative process may be further demystified and made more accessible to the observer.

In order to change perceptions, six myths of creativity have been identified. They are as follows:

- Myth 1: People Are Born Either Creative or Not Creative. As previously discussed, research suggests that individuals may enhance their own creativity, but this often times is not believed by the individual.
- Myth 2: There Is Limited Time to Be Creative (Aging diminishes creativity.) An oft held conception of creativity is that it is an ability that most children tend to possess. Much research suggests that older adults actually demonstrate the ability to be creative.
- Myth 3: General Creativity Does Not Exist. While there are data suggesting creativity is specific to an area, recent theory and supporting data suggest that some types of creative methods move across domains while others may be more limited within domains.
- Myth 4: Creativity Is a Touchy-Feely Phenomenon. Many seem to believe that creativity is this magical and mystical ability; only attained when one is not really trying to find it. Creativity can and has been studied using rigorous methods with well-conceptualized operational definitions.
- Myth 5: Group Creativity Works Best. Both group and individual creative strategies have advantages and disadvantages. These differing values are described in the next section of the article.
- Myth 6: Constraints Hinder Creativity. Although constraints may sometimes hinder creativity, they may also help provide positive guidelines that promote creativity.

These myths also represent a useful part of the framework for creativity enhancement programming via attitudinal change to be discussed later in the article.

Interpersonal Components

Several kinds of interpersonal interactions appear to facilitate the creative process. Two important skills are the ability to gain acceptance for one's creativity and the ability to work with others during the creative process. Although there is considerable debate about whether gaining acceptance for creativity (i.e., persuasion) is a vital component of everyday or only eminent creativity, the ability to market personal or group creative products can be a positive attribute [Plucker \(2016\)](#). Students should be encouraged to share their creative work with others. It is hoped that they will receive and benefit from this positive and perhaps even mild negative feedback. This may help them to develop the ability to convince an audience of their creativity. Other important interpersonal influences were suggested by Carl Roger's Humanistic theory and have empirical support. These involve the support of psychological freedom and psychological safety. According to Rogers (and the data supporting his ideas), these lead to the three internal conditions for creativity, namely openness to experience, the ability to toy with concepts, and an internal locus of the valuation (See Self-Actualization).

Working with others can both foster and inhibit creativity. Groups can serve as a detriment to creativity when members are simply told to 'do well,' when group goals are lacking, and especially when members do not have the freedom to work as individuals within the larger group. Conversely, groups tend to enhance creativity when members are socially comfortable with each other, when both the group and the individual members are held accountable for clear performance standards, and when group tasks are meaningful. Recall also the potential impact of evaluation, which can also be interpersonal. Efforts to enhance creativity via groups should keep in mind that collaboration and physically working in a group are not necessarily the same thing.

A seldom mentioned aspect of group creativity is the intergroup interaction as each group solves similar problems. By allowing group members to interact with other groups, the informal sharing of information and ideas can help members of a group overcome any functional fixedness that has developed. This perspective, which is based on the work of social constructivists, suggests that intergroup communication should be encouraged (See Group Creativity).

Problem-based and situated learning is also relevant to the discussion of interpersonal components of creativity. These constructivist-inspired strategies, which allow students to learn content and process skills through the solving of real-life problems, place a strong emphasis on the application of information rather than on simple memorization. Additionally, the realistic nature of problem-based and situated enhancement efforts fosters intrinsic motivation, which can be beneficial for creativity. Although situated learning makes sense in light of constructivist learning theories, situated approaches pose certain problems for the enhancement of creativity. Constructing knowledge and developing creative process skills may be more applied in a situated context, but they may be constructed and developed in a way that promotes functional fixedness. Problem-based learning activities should be designed so that students are required to apply factual and procedural knowledge in a variety of contexts, to interact with others as

part of the learning process, and to engage in some abstract thought (i.e., non-situated thought, which is frequently mentioned as a cognitive characteristic of creative individuals).

Environmental Components

The assembled research from the past 50 years paints a clear picture of the characteristics of a creativity-enhancing environment. The key characteristics are tolerance, moderation, and availability of resources. Thus, a stimulating environment should be created with a multitude of diverse materials (i.e., resources) available to stimulate ideas and create solutions. The not uncommon tendency to provide predominantly verbal materials should be avoided. Many individuals prefer to express their creativity through several domains, thus varied input (e.g., visual) should reflect this diversity of expression. In addition, given the importance of problem finding, it may be desirable to expose people occasionally to open stimulus environments, in which stimuli must be sought and problems need to be identified.

The environment should allow and even encourage reasonable risks to be taken, but irresponsible and physically dangerous risks (e.g., consumptions of drugs) should be discouraged. Everyday uses of creativity and problem solving are fostered by the management of risk, not simply by taking any risk that presents itself. In more general terms, the creative environment fosters the use of creative discretion, which separates originality from psychotic ideation.

Deviance and ambiguity are tolerated in the creativity-enhancing environment. Individuals should be encouraged when they think outside of accepted procedures and customs, and not criticized for ignoring cultural and experiential limitations. However, the environment should encourage self-regulation of creative processes so that even the most exhilarating dead ends can be self-identified and put aside. Divergent thinking needs to be linked with convergent thinking in the creative environment.

In general, the environment should be marked by balance: a mixture of structured and unstructured tasks that require divergent and convergent thinking, independent and group work, and procedural and declarative (factual) information.

Drug Use

Conventional wisdom posits that the use of certain drugs (e.g., alcohol, marijuana, LSD) can sometimes enhance personal creativity. Although certain aspects of creativity (e.g., affective, cognitive, interpersonal) may be positively influenced by drug use, research over several decades provides convincing evidence that – at best – moderate drug use has a negligible effect on long-term creative production and heavy use has a detrimental effect. Even in specific situations where a positive drug effect has been documented, the drug does not appear to encourage creative production. For example, several researchers have observed that alcohol consumption tends to lower a person's inhibitions, which is assumed to result in more flexible thinking and, therefore, greater creativity. However, this research has also shown that the disinhibition does not lead to enhanced creative production, rendering the effect of the alcohol most with respect to long-term creative productivity. Possible exceptions to these findings may be the use of caffeine and psilocybin, which may be correlated with creativity but are currently understudied in this regard (See Drugs).

Programs Designed to Enhance Creativity

Over the past few decades, several creativity training programs have been used to help people maximize their creative potential. These programs usually incorporate strategies that address multiple components of creativity.

Two types of programs have been designed to enhance children's creativity. The first involves modifications of the regular school curriculum, such as the Schoolwide Enrichment Model and Mentor Connection, the Talents Unlimited Model, the Cognitive–Affective Interaction Model, the SOI system, and the Purdue Creativity and Enrichment Models. The second includes extracurricular programs that may or may not be affiliated by educators attached to a child's school, including the Odyssey of the Mind and Future Problem Solving programs and numerous local, regional, and national invention programs. However, the distinction between these two types of programs is not universal, and programs frequently and successfully transverse this rather artificial boundary.

Within the business community, programs for enhancing creativity are quite popular. The increasing popularity of creativity in the business sector has led to an explosion in the number and type of programs aimed at this audience. In general, the components mentioned previously in this article are included in these programs, with predictable changes in terminology.

Plucker and his colleagues developed and evaluated a new approach to enhancement, one that focuses on attitude change as the precursor to enhancement. The model for the curriculum includes (a) changing schemas, (b) identification of personal strengths, and (c) acknowledging personal and external factors that may affect creativity, all addressed through a series of problem-based activities. The developers created two courses: an entry level course titled *Debunking Myths and Enhancing Innovation*, and an *Applied Creativity Seminar*, a capstone class for undergraduates. Pre- and post-course data suggest that students are able to overcome initial misconceptions and begin to change attitudes about creativity. This was particularly strong for the beliefs that creativity can be enhanced, that creativity can be defined, and constraints may enhance creativity. Although further testing of this model is needed

within the framework of the courses or similar courses at other universities, initial evidence suggests that focusing on attitude change rather than specific cognitive skills or behaviors may be a fruitful approach for enhancement programs.

Creativity Research in the Workplace

The application of creativity research extends beyond education into the workplace. Employers desire creative professionals to increase market competitiveness. In other words, they wish to enhance worker creativity to achieve corporate success. The research on creativity in workplace environments probes the dynamic relationships between the environment and the employee. It also attempts to differentiate workers' deliberate creative applications from their unexpected creative products, but these attempts are not always successful. Moreover, it is important to note the attempts to combine workplace definitions of creativity and innovation to reveal confusing patterns. Further research is needed to examine the relationships among the environment, the worker, creativity, and innovation. As creativity research advances, the intricacies of these relationships can become clearer.

Conclusions

Must all of the components be present in an effort to enhance creativity? As mentioned earlier, aspects of each component have been studied individually. Similarly, intervention efforts occasionally focus on only one or two components.

However, because each of the components is a necessary but not sufficient condition for creativity, enhancement efforts that consider the components collectively should be more effective than narrowly focused strategies. For example, if a person was to choose one component to exclude from enhancement efforts, which would it be: creating a supportive environment in which people are encouraged to take sensible risks, encouraging people to monitor their creative processes, or stressing the importance of interpersonal skills to creativity and the creative acceptance process? Each is clearly important and overlooking any of them (or any other aspect of creativity) would be difficult in light of the assembled research and theory. Although efforts to foster creativity need not focus on each and every component (and cannot do so effectively), well-designed programs consider all of the components and their interactions.

With the ideal that all facets of creativity should be represented in enhancement efforts, the following general guidelines appear to be reasonable.

1. Consider addressing misconceptions people have about creativity. For example, if a student does not believe he or she is creative and believes creativity cannot be increased, the best instruction for creativity enhancement will probably have little impact on that student's creativity.
2. Design activities that demand an individual's or group's attention. Capitalize on teachable moments such as current political, cultural, and community events. Try to address personally meaningful, intrinsically motivating topics.
3. Supply information about strategies and creators that is both useful and interesting. Information on the difficulties in building a canal or on intricacies of Einstein's general theory of relativity may not appeal to a group of marketing specialists, but stories about Einstein's struggle to get his ideas accepted or about the political creativity involved with constructing sky-scrapers may appeal to this group.
4. Provide either the skills and information that will generalize to other settings (e.g., the home, school, workplace) or opportunities to apply the introduced skills and information to different settings and problems.
5. Encourage people to share their creative work and learn how to incorporate feedback into their creative processes. Conversely, work with groups to learn how to provide constructive criticism that can improve and enhance the creativity of others.
6. Remove excessive evaluation and supervision from the creative environment. Micromanaging is just as disruptive to young students as it is to corporate managers.
7. Attempt to alter attitudes about creativity and originality and encourage creative confidence (i.e., creative self-efficacy) and risk taking.
8. Design activities that excite, stimulate, and increase curiosity and help people develop the intrinsic motivation to be creative.
9. Require problems to be solved individually and in groups. Have groups critically examine their own processes and attitudes (i.e., develop group metacognition) during and after the creative process.
10. Avoid making assumptions about students. Recent theory and research on intelligence, motivation, personality, and mindset provide evidence that individuals vary tremendously in their abilities, preferences, and attitudes. This diversity appears to be a critical element of creative production.
11. Similarly, introduce variety into enhancement efforts. This capitalizes on individual preferences and interests and promotes diversity in one's approach to finding and solving problems.
12. Consider the use of well-established programs that address multiple components of creativity and have already been field-tested and refined.

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Entrepreneurship

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Introduction

The Center for American Entrepreneurship defined entrepreneurship as “the process by which individuals or a group of individuals (entrepreneurs) exploit a commercial opportunity either by bringing a new product or process to the market or by substantially improving an existing good, service, or method of production. This process is generally organized through a new organization (a start-up company) but may also occur in an established small business that undergoes a significant change in product or strategy (see below on growth).” Parthasarathy, Daboli, and Paulus explained the relation between entrepreneurship and creativity as follows: to initiate a new business, entrepreneurs need a novel, financially sound, and technologically feasible idea that satisfies the need of a specific, large enough market. Accordingly, a business idea is the most crucial part of an entrepreneurial cycle and determines entrepreneurial success. Entrepreneurs need to be creative in order to identify new business opportunities so entrepreneurship and creativity have a natural affinity. This article considers this notion, drawing heavily on Parthasarathy’s research.

Entrepreneurship and Entrepreneur Definition

An entrepreneur is “a person who organizes the means of production to engage in entrepreneurship often under considerable uncertainty and financial risk. Entrepreneurs may partner with other entrepreneurs to jointly found companies (co-founders) or with an existing organization (e.g., corporate or university spin-outs).” In other words, entrepreneurship is the process of creating new businesses to deliver novel products, services, or a marketing state of mind. Entrepreneurship implies exceptionally optimizing the resources of production to innovate, improve customers’ lives, create wealth for enterprises, and add value to society. Entrepreneurs possess the required skills and initiative to bring novel ideas to the market. There is a continuous and conscious effort required to look for niches and undertake the risks in entering them. Entrepreneurs who prove to be successful in taking on the risks of a startup

are rewarded with profits and continued growth opportunities. Those who fail suffer losses and become less prevalent in the markets.

The Entrepreneurial Process and Embedded Characteristics

Entrepreneurial development begins with the conception and refinement of business ideas, followed by implementation and management. The process of creating prospective business includes the following six phases: (1) opportunity recognition, (2) idea incubation, (3) business preparation, (4) feasibility analysis, (5) implementation verification, and (6) management dynamics. This process is parallel to the traditional creativity process (i.e., problem finding, idea generation, and idea evaluation).

Phase 1: Opportunity Recognition

This is a key element of the new venture's creation process. Capable entrepreneurs identify gaps between demand and supply. These gaps may exist when certain things need improvement as well as when specific preferences or ambiguous requirements need to be satisfied. The identification of these gaps is a cognitive process that demands unusual perspectives. Accordingly, entrepreneurs evaluate opportunities to meet the market needs by introducing a product or service to improve, satisfy, please, or close the market gap. An entrepreneur's motivation, passion, and ability to recognize business opportunities determine business success. Thus, identifying market gaps, transforming them into opportunities, and generating business ideas to fulfill market needs are essential aspects of this phase.

Phase 2: Idea Incubation

Seizing evanescent business opportunities requires the formulation of novel and unique business ideas. These ideas must be incubated through candid self-examination to identify entrepreneurial skills and then implemented with market research to identify customers' requirements. During the incubation phase, ideas that have the potential to solve problems are generated. This phase is characterized by the conscious or unconscious thought process for refining an idea. Incubation leads to the clarity of ideas. This creativity process is referred to as re-creativity, as it takes inspiration from existing ideas and molds them in an innovative way. Accordingly, a self-disciplined process of evaluating and refining business ideas must be executed throughout the entire entrepreneurial process.

Phase 3: Business Preparation

This stage involves the preparation of some practicable ideas. There has to be some inspiration that forces or prepares entrepreneurs to move forward. This is a critical stage for entrepreneurs to stay motivated and launch their ideas in the form of a business plan; they must also consider the availability of resources required. An entrepreneur identifies the target market and makes adjustments to suit market needs for a start-up or expansion. This is done in an effort to identify a viable solution. Through business preparation, entrepreneurs zoom in and out to examine all possible directions to solve the problem, be it inside the industry or outside. In short, transforming thoughts into actions and flexible adjustment to suit market requirements are essential for business preparation.

Phase 4: Feasibility Analysis

In this phase, entrepreneurs decide to seek, obtain, and use resources. Entrepreneurs have identified the market gap and opportunities and outlined a business plan after considering the financial implications for start-up. A series of light tests, corrections, and retests are conducted to prepare a business plan poised for growth. If potential customers perceive value in the offering and are willing to pay for it, this implies the pressing need from the target market and validates the business idea. At this point, entrepreneurs would focus on acquiring financial backing for their business ideas. Obtaining funding is one of the major obstacles to start a new business. Entrepreneurs invest resources to ensure a positive first impression on their customers. Considering financial burdens, getting potential customers to bank on the business practices is a major breakthrough.

Phase 5: Implementation Verification

This stage determines whether the new found business practice has the potential to work or not. No business can stay afloat without customers. Entrepreneurs aim to acquire as many customers as possible at a reasonable cost as well as to retain them in the most effective way. Accordingly, entrepreneurs are required to consider customer acquisition and retention costs while operating their businesses. Offering exceptional customer services may attract customers and win their trust. Happy customer testimonials build a sense of trust in people who have not patronized their business before. Therefore, honest opinions about the business practice must be provided by entrepreneurs. In short, the business practice can be either accepted, modified with changes, or rejected altogether to safeguard its implementation.

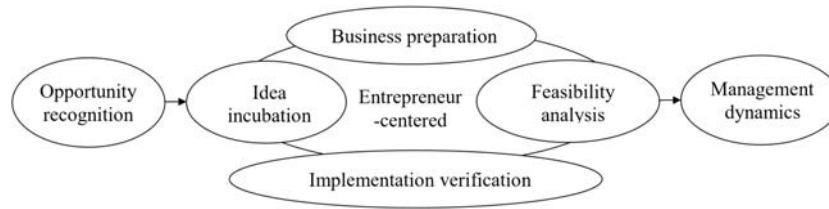


Figure 1 Entrepreneurial process.

Phase 6: Management Dynamics

The major success of any entrepreneurial effort depends on critically examining the feasibility of an idea. After operating for a few months, entrepreneurs could see if their start-ups show increased, constant, or decreased sales. Although every entrepreneur strives for victory, any entrepreneurial process could result in success or failure. If the business model used does not work, entrepreneurs could revisit the events that led to its failure. Highlighting their areas for improvement, entrepreneurs could accumulate experiences over time that would help them handle most problems. As the business develops, customer satisfaction and revenue growth are critical. In short, creating and managing a business are difficult; the viability of business practices can lead to the creation of actual enterprises or the improvement of existing ones.

The entrepreneurial process is bounded by context rather than a step-by-step approach. As illustrated in Fig. 1, this process comprises six phases without strict boundaries. The entrepreneur starts with opportunity recognition and then moves through the phases of idea incubation, business preparation, feasibility analysis, and implementation verification. The invention of business ideas and the refinement of associated practices in each phase influence those in the next phase, eventually leading to the management of market dynamics.

Significance of Creativity in Entrepreneurship: Four Challenges

Entrepreneurship is a multifaceted and somewhat risky career path. Qualities such as intelligence, passion, and determination can help entrepreneurs achieve success. Nevertheless, creativity should be valued above all others because entrepreneurs are required to produce innovative ideas and ensure business success. Creativity is not only the accelerator of entrepreneurial development but also a stronger predictor of business success than intelligence. Creativity is a characteristic that distinguishes them from traditional businessmen.

Entrepreneurs face the following challenges:

Opportunities Should Not Be Overestimated

A start-up typically begins with a small business having immense flexibility. Identifying opportunities and visualizing ways to activate them particularly need creativity and are crucial for small business entrepreneurs. However, many entrepreneurs are keen on seizing opportunities or are over-optimists to diversify their business operation. Numerous successful entrepreneurs do not launch a radically new product so much as a significantly improved one. Entrepreneurship increases an enterprise's wealth and adds value by rising economic activities resulting from optimizing the entire process. Changing the manufacturing method for the products or shifting ways of supplying products and delivering services to customers can create a niche with great business potential.

Accordingly, a careful market opportunity analysis should be conducted for identifying customer problems and satisfying unmet customer requirements. The following steps assess the attractiveness of a new market opportunity: (1) understanding the current business environment, (2) identifying potential markets, (3) defining profitable targets, (4) diving into the details of competitors, (5) offering an attractive prospect to the target market, and (6) setting and testing sales projections. Creative insights are required in-between these steps for integrating customer information, available resources, and competitive readiness in a meaningful manner, ensuring that opportunities are not overestimated.

A Business Idea Must Have Potential Economic Value

Divergent and convergent modes of thought must be combined for entrepreneurs to have creative breakthroughs. A divergent approach generates creative ideas by exploring possible solutions to the same problem at the intersection of disciplines. Most breakthrough discoveries, including exceptional business ideas, occur when two or more disciplines collide, allowing entrepreneurs to view a problem and decipher potential solutions from a new perspective. A convergent approach is highly analytical and focuses on arriving at one accurate solution given the available data and resources, frequently working with computer systems and accounting software.

Creativity requires structure for successful execution, but the structure should not be too rigid. Business ideas cannot be exceptional unless their economic importance is highlighted. In other words, creative business ideas work best when harnessed with

highly focused and disciplined thought. Exceptional business ideas result from following a divergent approach at the preliminary stage and convergent approach at the execution stage, giving entrepreneurs an edge over the competition.

Nonstop Innovation Is Vital

Creativity extends the limits of entrepreneurs' mindsets and skill sets. It enables people to connect dissimilar and unrelated subjects and generate successful entrepreneurial ideas. Although some innovations are incremental in nature, interdisciplinary collisions are essential for transcending the boundaries established by different professions. As such, feasible resolutions from unrelated concepts can be explored before potential path-breaking discoveries. Capable entrepreneurs repeatedly seek innovation to thrive for success. Their current idea is often only a transition into another idea because situations constantly change in a start-up.

Adapting to circumstances and putting continuous efforts to generate new ideas are a part of entrepreneurship. Entrepreneurs' market success represents that competing products or services, better than theirs, will be promptly developed and delivered. Accordingly, entrepreneurs must ensure conscious efforts to innovate their products or services and continuously search for niche markets. Therefore, capable entrepreneurs think in original ways to generate interesting, versatile, unthinkable products or services and yet have the potential for success.

Entrepreneurs Must Be Risk-Takers

Entrepreneurs are required to undertake risks to redesign their products or services to stay ahead of their competitors as well as to relocate their existing business workflows for effective implementation. They are required to leave their comfort zones and consider conflicting opinions. Creativity allows entrepreneurs to disconnect from the accustomed and move into uncharted terrains to discern unique and useful solutions. Patience is required to observe the fruitful outcome of business ideas and practices. It takes time and effort to transition from conceptualization of ideas to their implementation.

A start-up typically has limited funding and faces a constant struggle to maintain positive cash flow, requiring entrepreneurs to exploit their creative resources. The entrepreneurial process rewards entrepreneurs by increasing their profit potential. However, entrepreneurs must step in and resolve problems themselves. The ability to foresee situations in detail, identify the choices, and visualize the best decision demands creativity. There is always room for improvement in the deliverables of an enterprise; capable entrepreneurs have the skills and vision to assess how to do it. If they do not optimize their businesses, they will promptly lose market share to newcomers.

Entrepreneurial Creativity and Entrepreneurial Intentions

Researchers have extensively reviewed entrepreneurial creativity and entrepreneurial intentions. Entrepreneurial creativity is defined as the business capacity to discover and exploit business opportunities for generating and implementing creative ideas, thereby establishing new ventures or reviving existing organizations. Entrepreneurial creativity can be assessed in terms of originality and usefulness. Entrepreneurial originality refers to the capability to generate business thoughts and practices considered to be novel or unique within the marketplace. Entrepreneurial usefulness refers to the capability to generate business thoughts and practices considered to be appropriate, effective, or valuable within the marketplace.

Extrinsic and intrinsic factors influence entrepreneurial activity. Among the extrinsic forces, the role of cultural background should be emphasized. The behavior of individuals largely reflects their cultural background. Cultural background offers a range of social stereotypes and rules that form an individual's frame of mind that contributes to their understanding of the world. Specific cultural characteristics, such as allowing new ways to work and live, encouraging individual achievements and perspectives, and having high rates of innovative activity, are labeled cultural creativity.

The second force is institutional environment, which is influenced by cultural background and political operation to create structures and incentives for individual and group actions. The structures and incentives are formed as economic stability, capital availability, personnel regulation, legal protection, and the degree of power centralization. In addition, the management of resource availability is a critical force to boost creativity, particularly when creative capital must be funded. Technological advancement, another frequently mentioned extrinsic force, leads to a sharp change in performance to drive discontinuous capability improvements and product developments. This would create new business opportunities and investment options and result in new potential market and customers.

Personality traits should be highlighted as an intrinsic force that enhances creativity. Over the years, numerous researchers revealed five traits of creative individuals: high openness, low agreeableness, low conscientiousness, high extraversion, and low emotional stability. Furthermore, entrepreneurial creativity demands motivational synergy resulting from a combination of intrinsic motivation (i.e., strong levels of personal interest and active involvement) and certain types of extrinsic motivation (i.e., supportive incentives) to empower further achievement. Moreover, emotions can negatively impact human reasoning and creative thinking. Numerous studies have further indicated that self-efficacy influences workplace creativity, a key driver of organizational innovation and success.

Research studies also suggested that social support leads to ideational productivity and creative performance. In addition, prior experience has been identified as a crucial predictor of creative performance because it may help people avoid unnecessary try-outs

and lead them to possible resolutions. However, some studies suggested that prior experience may not always be beneficial to market alertness and business creation. Furthermore, the greater the knowledge base of individuals, the more the ideas and the combinations that they can achieve. Accurate knowledge management metrics allow an organization to become more creative and sustainable, thereby achieving a competitive advantage. High levels of creativity are associated with a high level of education, which encourages individuals to think in a certain way by equipping them with the necessary tools to develop innovative practices in the future.

Entrepreneurial intention is defined as a person's self-acknowledged conviction to establish a new business venture and the conscious planning to do so in the future. Research indicated that entrepreneurial intention is a strong predictor of planned behavior and functions as a mediator or catalyst for entrepreneurial action. Entrepreneurial intention comprises two factors: conviction and preparation. Entrepreneurial conviction refers to a strong belief or opinion toward entrepreneurial career commitment. Entrepreneurial preparation refers to the activities or processes that prepare a person for being an entrepreneur.

Accordingly, cultural background, institutional environment, resource management, technological advancement, personality traits, motivation, emotions, self-efficacy, social support, prior experience, knowledge base, and educational levels play critical roles in facilitating entrepreneurial intention. In addition, previous studies tested and validated that entrepreneurial creativity can serve as a robust mediator between the aforementioned factors and entrepreneurial intention.

Entrepreneurial conviction is influenced by both dimensions of entrepreneurial creativity, whereas entrepreneurial preparation is strongly influenced by entrepreneurial originality. Thus, educators should inspire students to implement their unique ideas and encourage them to generate novel works, thereby facilitating entrepreneurship preparation. Educators can lead students to construct effective ideas and assist them in generating valuable works, thereby further promoting entrepreneurship conviction. In addition, educators should provide positive experiences for students to engage in entrepreneurial activities and embed career flexibility into their coursework design and placement experience planning.

Ways to Boost Entrepreneurial Creativity

Everyone is born with creative potential. Creativity is a renewable resource that can be tapped into at any time, and the creative process can be improved and reinforced. Inculcating new hobbies can be an ideal way to put individual creativity to test and hone creativity. Entrepreneurs cannot always depend on aha moments for professional achievements. Intrinsic factors such as motivation, emotions, self-efficacy, perceived social support, prior experience, and knowledge base can be altered to boost entrepreneurial creativity.

Take Mental Breaks

The best way to refresh the brain is to step away from the workplace and take breaks for pushing oneself over the last mental hump before all good ideas are squashed. Relaxing on a comfortable sofa, reading an article, listening to music, or drinking a cup of coffee or beer can reboot creativity and lead to the generation of ideas. Dimming the surrounding lighting to reset emotion and letting the mind drift can actually advance creativity, lower inhibitions, and even raise one's determination. A calm and uncluttered mind is beneficial to entrepreneurs for enabling their creativity to flow. Neuroscientists confirmed that exercise can accelerate the birth and survival rate of new brain cells of the hippocampus, a region responsible for human memory and for the ability to imagine the future and to think creatively. Going for a run can sharpen peoples' minds, help them to stay focused, and allow them to detach from their subject experiences to observe their own thoughts. In short, beyond mental dexterity, creativity thrives when there is emotional balance and mind relaxation.

Change Comfort Zones

Comfort means to set boundaries around one's accustomed frames and a state of physical ease. However, with high levels of motivation and self-efficacy, capable entrepreneurs change comfort zones to contribute to business success. Sometimes, revisiting and visualizing things from a different perspective can help entrepreneurs separate themselves from stressful situations. Entrepreneurs may devise new ways of doing the same task. Working backward may provide entrepreneurs with smarter solution and keep their creative spark bright. In brief, possessing multiple comfort zones that can be freely moved in and out of helps entrepreneurs to identify viable ideas for business growth.

Encourage Knowledge Sharing and Welcome Constructive Criticism

By exploring different roles, entrepreneurs can adapt to changing and make accurate decisions. Successful entrepreneurship requires sufficient viable ideas. Creative thinkers need to think of all possible alternatives, which help in compiling diverse ideas. Through sharing ideas, taking criticism, and soliciting feedback, multidimensional perspectives may be drawn. In short, a team of creative thinkers can be the greatest asset for every entrepreneur, and every creative mind increasing an enterprise's value should be well rewarded.

Evaluate Business Ideas and Practices Against Goals

Capable entrepreneurs complete short-term tasks while keeping long-term goals in mind. These goals should be displayed, so that entrepreneurs can work to achieve them every day, in addition to keeping weekly plans. In the start-up process, entrepreneurs never consider a static plan; instead, they keep evolving the plan because it always can be inspired from emerging thoughts by transforming and combining them.

Free thinking is a primary business practice nowadays; it must revolve around a specific goal with some parameters. Some checkpoints offered by Princeton Creative Research are as follows: thinking based on realistic needs, pinpointing issues for resolution, having expected outcomes of implementation, knowing limitations and risks involved, demanding simplicity in implementation, grasping needs of potential customers, and accompanying marketing strategies. In short, devising easier plans and evaluating business ideas and practices against goals can help facilitate successful entrepreneurship.

Social Entrepreneurship

Definition and Importance

The social entrepreneurship movement is gaining momentum worldwide, and business school leaders have identified it as one of the most in-demand areas of business research. Social enterprises are organizations that combine social missions with financial autonomy in a competitive corporate environment. Social enterprises improve social welfare through the commercialization of goods or services. These organizations are innovative agents that engage the market and harness its wealth-generating power for serving disadvantaged social groups and achieving social transformation. They use commercial operations to promote their claims of social, environmental, and practical justice. In short, social entrepreneurship aims to resolve social problems through social entrepreneurs who establish liaisons between social causes and entrepreneurial actions in organizations.

Three major schools of thought exist regarding the concept of social enterprise: “earned income,” “social innovation,” and the “EMES (EMERGENCE des Entreprises Sociales en Europe [the European Social Enterprise Research Network]) approach.” The earned income approach refers to the use of commercial activities in support of a nonprofit organization’s (NPO’s) social mission; social innovation approach refers to playing the role of a change agent by pursuing new opportunities to serve a mission to create and sustain social value. The EMES approach refers to those financially autonomous NPOs providing goods or services related to their aim to benefit the community. This article considers a social enterprise as the use of commercial methods for social innovation and financial sustainability in support of an organization’s creation of social values.

The importance of social enterprises has been affirmed twice by the Nobel Prize. For the first time, in 2006, the economist Yunus was awarded the Nobel Peace Prize for creating the Grameen Bank in Bangladesh, which grants loans to poor people through innovative operations to improve their lives. The Grameen Bank has advanced to the forefront of a burgeoning world movement toward eradicating poverty. The Grameen Bank model has been duplicated in over 100 countries worldwide.

The second affirmation was in 2009, when the Nobel Prize went to American political economist Elinor Ostrom who examined ways communities cooperate with each other and conduct joint resource governance. Ostrom demonstrated that local property can be effectively managed by local communities without any regulation by central authorities or privatization. This insight helped people appreciate human behavior by advocate for communities that self-organize in ways that punish those who take undue advantage of common resources.

Social enterprises are increasingly compelled to engage in the market economy, and they share characteristics with earned income ventures initiated by conventional nonprofits because both are driven by the dual goals of social benefit and trade revenues. In addition, social enterprises have used their community-spirited motives to attract human and social capital and engendered survival strategies premised on grant dependency. Because of its dual-targeted characteristics, social entrepreneurship often creates nonprofit sector jobs, fosters workforce development, and provides people with supplemental income, often by strengthening ties between entrepreneurs and the formal economy and building social capital.

Performance of Social Enterprises

With the increasing use of managerial practices, optimization has become crucial for organizational performance. The issue of performance measurement in social enterprises has gained increasing relevance among researchers and practitioners. Previous studies indicated that performance measurement for social enterprises must include both organizational performance and social impact. Studies also suggested that entrepreneurs, management teams, and service programs play critical roles in the performance of social enterprises. Next, the performance measurement of social enterprises will be discussed according to four categories: personal characteristics, social impacts, business operations, and service programs.

Critical problems in personal characteristics include entrepreneur leadership, entrepreneurial values and motives, strategic partners, employee quality, internal knowledge sharing, and entrepreneurial intensity. Social impacts include government support, social needs, prospective ideas, environmental sustainability, synergy creation, and positive change. Business operations include market position, organizational culture, partner relationships, financial capital, infrastructure, innovativeness, knowledge transferability, organizational structure, business planning and marketing, and regulatory environment. Finally, service programs include activity design, sustainable product, service delivery, and social ties.

Studies on personality traits have revealed that extraversion positively influences service programs and that openness negatively influences service programs possibly because open people have difficulty focusing on tasks that require intense patience and most social problems cannot be resolved overnight. Neuroticism and conscientiousness positively influence personal characteristics and service programs, and agreeableness positively affects all dimensions of perceived performance of social enterprises.

Research reveals that social entrepreneurs exhibit higher levels of entrepreneurial creativity than commercial entrepreneurs. Studies regarding imaginative capability indicated that although conceiving and transforming imagination are positively related to all dimensions of perceived performance (i.e., personal characteristics, social effects, business operations, and service programs), initiating imagination is negatively related to the dimensions of business operations and service programs. Conceiving and transforming imagination are closely associated with the usefulness aspect of creativity, whereas initiating imagination is strongly related to the originality aspect of creativity. Some interactive relations exist between conceiving imagination and initiating imagination on the dimensions of personal characteristics, social impacts, and service programs. In addition, some interactive relations appear between conceiving imagination and transforming imagination on the dimensions of personal characteristics and social impacts.

Social Entrepreneurial Intention

Increasing focus has been placed on social entrepreneurship worldwide, particularly among the younger generation. Most social entrepreneurs are aged 25–40 years. Scholars proposed empathy, moral judgment, self-efficacy, and perceived social support as antecedents of social entrepreneurial intention. Some scholars have suggested replacing moral judgment with moral obligation; however, recent studies have confirmed that social responsibility can be a better substitute for moral judgment. In addition, research has proposed and successfully tested prior experience with social problems as a robust predictor of social entrepreneurial intention. Recent meta-analytic studies have reported that people with social entrepreneurial intention score high on personality extraversion, openness, conscientiousness, and agreeableness but low on neuroticism. Furthermore, studies have indicated that social entrepreneurs exhibit significantly higher levels of entrepreneurial creativity and risk-taking ability compared with traditional entrepreneurs.

Scholars have critically examined the aforementioned variables and have concluded that prior experience with social problems, perceived social support, and originality in creativity are verified as the most prominent influencers of social entrepreneurial intentions of university students. Particularly, personality traits and prior experience with social problems can predict social entrepreneurial intentions through the mediation of entrepreneurial creativity, empathy, social responsibility, self-efficacy, and perceived social support. Furthermore, originality in creativity, cognitive empathy, and bonding social support have the strongest positive effects, whereas the stockholder perspective of social responsibility has the strongest negative effects on social entrepreneurial intention. Research results have also shown that this mediating model provides different outcomes across academic fields, socioeconomic contexts, and work experiences mainly because of the variances in prior experience with social problems, cognitive empathy, and usefulness in creativity.

Some scholars have focused on this line of research by examining the manner in which perceived potential helps journalists and NPO managers become social entrepreneurs. Research has been conducted on journalists because the skill sets necessary for success as an entrepreneur are a part of the genetic makeup of journalists, whereas research has been conducted on NPO managers because NPOs currently run in an increasingly turbulent context where the operating pressure has become challenging, especially with the slowdown in the global economy. Recent studies have revealed that entrepreneurial creativity, prior experience, perceived social support, social responsibility, and personalities of conscientiousness and openness have determinant influence on the social entrepreneurial intention of journalists. For the NPO managers, entrepreneurial creativity, bonding social support, cognitive empathy, and social responsibility are the major driving forces to becoming social entrepreneurs.

Critically, numerous studies on entrepreneurship at personal and cognitive levels lack contextual hints. However, different regions are heavily influenced by dissimilar cultures. Abundant research at national and economic levels lacks individual considerations. Without elaboration on macrohistories and micro considerations along with their intertwined connections and supplemental explanations, entrepreneurship assumptions may be unwarranted. Furthermore, with growing public concern and support for social entrepreneurship following the global financial crisis, the opportunity and context for such novel developments may now exist; however, public funding is tightly constrained. A key approach is to continually evaluate the extent to which intrinsic and extrinsic interactions of person–context relations are influenced by the unexpected dynamics of upcoming social and environmental problems. The new demand and opportunity for further research on diverse social entrepreneurship topics are currently emerging.

Conclusions

The association between entrepreneurship and creativity has been extensively discussed in the literature. This article provided a comprehensive outline focused on entrepreneurship and the essential phases in the entrepreneurial process.

The global economic environment is volatile, demanding renewed dynamism in the approach employed. Progressive entrepreneurs hone creativity to ensure that their organizations evolve and remain dynamic as well as to please their customers. They understand how creative solutions emerge when they observe and engage and are mindful of their surroundings, through which their business acumen and prospects can be greatly expanded. To maneuver start-ups, every entrepreneur requires passion,

determination, the ability to innovate, and entrepreneurial creativity. Entrepreneurial creativity cannot exist without vision, optimism, and self-disciplined thought, in addition to initiation, tolerance, and persistence from within.

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Relevant Website

Center for American Entrepreneurship, <https://www.startupsusa.org/>.

Everyday Creativity[☆]

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Glossary

Everyday creativity As product, meets two criteria after [Barron \(1969\)](#), *originality* and *meaningfulness*. Can apply broadly beyond “stereotypical” activities in arts and sciences, being relevant to work and leisure, family, relationships, and much more. “Less what does than how one does it.” Everyday creativity has been operationalized by the *Lifetime Creativity Scales* (Richards et al., 2012), with high interrater reliability and multiple indicators of construct validity.

Four Ps of creativity Per Rhodes (Richards, 2018) involves four perspectives on our “originality of everyday life,” including product, process, person, press. Product is the outcome (e.g., object, idea, performance); process, how it is generated; person, the creative individual; press is environmental context. At times, for example, relational creativity, process also becomes product.

Mindfulness Insight-oriented practice involving awareness in the present moment, nonjudgmental, without attachment or preference, with openness, curiosity. Central practice in varied spiritual traditions (e.g., [Goleman and Davidson, 2017](#)), also showing long-term changes in brain. Numerous benefits in everyday life involve stress reduction, peace, calm, health, well-being, and factors in creative openings.

Open systems Involves changeable yet self-sustaining entities (such as any of us); we are never the same, but “autopoietic,” the ongoing result of “self-construction,” a “self-maintaining process by which a system functions to... continually produce the components... which themselves make up the system” ([Mitchell, 2009](#)). [Zen Master Thich Nhat Hanh \(1998\)](#) calls our interconnection in this context “interbeing.” See also [Tarthang Tulku Rinpoche \(1990\)](#). For chaos and complexity, see [Schuldborg, Richards, Guisinger, eds. \(in press\) Nonlinear Psychology](#).

Person-centered expressive arts Process-focused and group interactive multimodal exploration for self-discovery and growth, developed by Natalie Rogers (2009), and incorporating Carl Rogers’ safe environment and client-centered principles (see [Goslin-Jones and Herron, 2016](#)). Interventions can include a trajectory integrating meditation, movement, visual arts, writing, sounding, and more.

Relational creativity Everyday qualities of originality and meaningfulness can be found in rich, present, authentic, interactions between living beings, marked by conscious awareness, give and take, spontaneity, and openness—along with central

[☆] *Change History*: September 2019. Ruth Richards & Terri Goslin-Jones updated the text throughout the article.

This article is an update of R.L. Richards, *Everyday Creativity*, Editor(s): Mark A. Runco, Steven R. Pritzker, *Encyclopedia of Creativity* (Second Edition), Academic Press, 2011, Pages 468–475.

empathy—allowing change and growth in the involved parties. Relational processes can manifest through engagement, authenticity, empathy, mutuality, and empowerment (Jordan et al., 1991; Richards, 2007).

Everyday creative potential offers a universal capacity essential in human evolution. The issue is less “what one does than how one does it” (creative process is more central than product) whether making dinner, reorganizing the office, or painting a canvas. According to humanistic psychologists, creativity can even advance human development to its highest potential.

We seek what we need, and it turns out to be who we are. This article asks four questions: What is everyday creativity? Is everyday creativity healthy? How “normal” are everyday creators? Can people become open more to creative living?

What Is Everyday Creativity?

The “originality of everyday life” on one hand has been vastly important to human welfare and evolution itself, invoking at a level of *process*, a universal capacity to be open, aware, and present, to adapt flexibly, improvise, intuit, shift, try things, and make room for the new. Many people have a “feel” for these universal creative beginnings, but do not notice them, name them, or even think to call them creative. Hence, everyday creativity can, on the other hand, be misunderstood, overlooked, or even invisible. Everyday creativity is less about *what one does* than *how one does it*.

Ubiquitous yet overlooked? Everyday creativity has long been studied by researchers and the benefits identified. A person travels a new way to work or improvises on an oral report they forgot was due. Did they credit themselves with creativity? Researchers recalled an auto mechanic who invented his own tools, an economical homemaker who designed unusual clothes, a parent who engineered a special chair for a disabled son. These participants were studied by Richards, Kinney, Benet, and Merzel, and others at Harvard Medical School and McLean Hospital as they developed and extensively validated the *Lifetime Creativity Scales (LCS)*.

Originality and Meaningfulness

The Lifetime Creativity Scales or LCS operationalized everyday creativity, using interview-based assessments of quality and quantity of real-life creative activity at work and leisure. The dual *product* criteria of “originality” and “meaningfulness” were employed after Frank Barron. Creative outcomes (products, behaviors, or ideas) showed novelty or relative newness (originality), against well-defined rating levels while neither random nor idiosyncratic (thus, meaningful). The popular criterion of “usefulness” was bypassed to minimize culture-bound judgments, meanwhile crediting unusual outcomes where only “time will tell.” The creativity-inhibiting effect of “judgment” was also avoided because of the many possibilities which abound for how creativity may emerge, when viewed as a way of life. (See Kinney, Richards, & Southam, 2012, including the actual LCS). This omnipresence provides an advantage in research with general populations versus groups with a homogeneous criterion (e.g., only artists or chemists or entrepreneurs). For example, one can study participants in an experimental class, or people with ADHD, assessing a wide range of everyday creative outcomes.

Sensitivity training. Researchers began to see “creativity” in areas previously missed, e.g., in home décor, furniture repair, planning a vacation, teaching a class, or leading a fund-raising event. The arts, sciences, and traditional areas of research were also included. Cross-cultural validity was documented when the LCS was translated from Portuguese by Shansis and associates, and used with a Brazilian population.

There are endless possibilities for human creativity, or what evolutionary biologist Dobzhansky called “phenotypic plasticity”—the many ways humans can vary within the bounds of our genetic (and epigenetic) potential. The job of creativity researchers is to capture a variety of outcomes, however unexpected, and to reveal new findings.

The Three Us and Four Ps

If everyday creativity is Underrecognized, Underdeveloped, and Underrewarded—i.e., The Three Us—then it will not be identified, or celebrated at work, school, or home. Instead, one can use Rhodes’s Four Ps of creativity to look not only at the creative *product*, but creative *person* and *process* across diverse populations (who is doing this, and how—and *what is it doing for them?*), and under what conditions (*press* of the environment). These perspectives can also draw from. Runco and Kim (2011) added two further Ps: creative *potential*, on the front end, and later (after Simonton) creative *persuasion*, in a creation’s effects on others.

One Creativity or Many?

Commonalities are also of note. Frank Barron wrote, “Originality is almost habitual with highly creative people” (in Richards, 2018, p.19). Creative *process* and ongoing *person* traits are both relevant, as one responds to life circumstances with originality as a habitual

tendency. This resonates with other “core characteristics” of highly creative persons across fields. Included is Openness to Experience, from the Five Factor Theory of Personality. Hence, “One creativity or many”? According to Amabile, creating can also draw on “something else,” more general across domains, and inviting novelty while giving creativity its “special flavor.”

Broad-based real-life assessment opens research doors. Creativity assessment can be done across many fields. Populations are chosen to study creativity for other reasons, e.g., involving psychiatric diagnosis, childhood experience, special interventions, and to find their “originality of everyday life” wherever it may emerge, in work or leisure. Research studies of creativity and mental health with the broad-based LCS depended on having a broad-based assessment of real-life everyday creativity, however it may emerge, applicable to anyone, in any area—for individuals and also for *families* carrying risk for bipolar or schizophrenia spectrum disorders. This led, with research on well-validated pedigrees of risk-carrying relatives, to important findings stressing *health* as a factor and, for some, potentially, creativity as one of their best medicines. Findings have been supported by other results, in varied and edited collections by Kaufman, Runco and Richards, Goodwin and Jamison, and others. Millions of patients and families may benefit from knowing about: (a) an *everyday* creative advantage within individuals and families at risk, e.g., for bipolar or schizophrenia spectrum disorders, meanwhile (b) linked to *better functioning* (overall, or to certain states), and predicting for *health*.

Is Everyday Creativity Healthy?

Some important areas of health and healing include as follows:

Health and Healing

Verbal and nonverbal creative expression. Pennebaker and colleagues established that expressive writing about difficult and even traumatic issues, for experimental versus control participants, can lead to integration and higher well-being, fewer health center visits, and by contrast with controls *higher immune function*.

Related work in books such as *The Writing Cure* confirmed that verbal expression offered integration and higher working memory. Examples of writing for health and self-development are numerous, including Borkin’s and Cameron’s programs. In addition, there are health benefits from using writing and multimodal expressive arts, included in the work of Natalie Rogers.

Imagery and healing. Achterberg, Freeman, Schlitz, Singer, and others documented the power of imagery to help in healing. Personally created images can work best. For the disbeliever, Freeman even noted how visualization can reduce local blood flow. Jung saw imagery as a powerful mind–body bridge, and imagery has been used for physical problems including cancer, HIV, eczema, and more, plus a range of psychological situations, and in psychotherapy.

Appreciation of creativity. Pritzker discussed active audience engagement, “audience flow,” and healing, and Zausner wrote about the transformative potential within an art audience in Richards’ edited collection *Everyday Creativity and New Views of Human Nature*. Richards noted the power of empathy including roles of mirror neurons. Interestingly, Creative Appreciation has been statistically associated with everyday creativity by Richards, Kinney, and associates. This link may not seem surprising, in a larger *systems context*, where “open systems” are mutually giving and receiving; then sharing and building insights atop and alongside others. Interesting indeed (although interpretations are multiple) are findings by Levy and Langer on *vicarious creativity* for 12,000 people in Sweden, enjoying plays, concerts, and more compared to controls. Among the benefits they *actually did live longer* from their experiences of vicarious creativity.

When Everyday Creativity Is Invisible

Naming Everyday Creativity. It is surely not helpful for creative resilient coping or confidence when one overlooks one’s own potential—and neglects to identify or name personal creative expression. By contrast how wonderful when it is seen, e.g., day-care providers, in vital yet underpaid jobs (some believe salary reflects value), who suddenly realized how profoundly creative and even life transforming their work can be.

See **Table 1** below for misunderstandings about what everyday creativity is and is not.

Everyday origins of eminent creativity. The eminent artist, writer, diplomat, entrepreneur, scientist—people whose work transforms minds, changes cultures can be honored for their creative endeavors. Yet in a larger systems view, there are a wide variety of cultural and creative “niches”; and creative expression has a wider zone in which many people can play. Eminent creativity begins (and continues) at the everyday level, the ground from which it grows. Surely, dynamic creative growth (vs. stasis) predicts for a healthier culture.

Eminence itself derives from a social judgment where the general population, or experts in a field of endeavor, weigh in on excellence. As with Creative Appreciation, an everyday creative populace is more apt to see and accept the new. It is worth considering the 50 million *Cultural Creatives*, studied by Ray and Anderson, moving toward greener, healthier, and more innovative lifestyles, both as everyday innovators and “early adopters.” This picture of creativity and well-being is shaped at many levels.

Misleading negative attributions. Already noted were misunderstandings about creativity and mental illness. Links between personal/family history and bipolar or schizophrenia spectrum disorders *are actually nonlinear, multivariate, and are really about access to innovative material balanced by adaptive functioning*, according to Kinney and Richards, Silvia and Kaufman, and others. Creative benefits go to the better functioning individual—or person at a better functioning time. For instance, according to Kaufman and

Table 1 Everyday creativity: Seven common misunderstandings

<i>Everyday creativity is...</i>	<i>Rather, everyday creativity...</i>
1. NOT an optional “extra” for all but certain famous people.	IS a <i>universal</i> capacity for survival and participation in life.
2. NOT limited only to special areas such as the arts or sciences.	IS found in all parts of life, at work and leisure. “It is less <i>what</i> you do than <i>how</i> you do it.”
3. NOT merely a light and pleasant diversion for relaxation and to fill some time.	IS a vital enterprise involving commitment, flexibility, risk-taking, openness, and can even transform self and culture.
4. NOT an enterprise designed to unsettle and evoke pathology—although sometimes unsettling.	IS one that can go deep into the psyche where it can open, integrate, and heal.
5. NOT an endeavor focused only on creative end-products (concrete outcomes, ideas, behaviors)	IS one involving a healthy open flexible and richly aware <i>way of life</i> which can connect more meaningfully with the world.
6. NOT an activity set apart from much of our being, from concerns, or illnesses.	IS one that reaches deep into mind–body–spirit, and can help passions, and healing, including mind–body healing.
7. NOT a neutral or safe activity that risks little, to the creator, to others, or the social context, and which evokes no inner or outer resistance.	IS a potentially challenging, even dangerous enterprise offering disruption and change—including personal reorganization and threats to society’s <i>status quo</i> .

Adapted from “Everyday creativity—Our hidden potential,” in Richards (2007, 47–48)

Gregoire, factors related to openness (such as low latent inhibition) need to be balanced with executive functions, for adaptive use of creative material.

Creating Toward Higher Purpose

Greater good versus malevolent creativity. Creativity can also be used malevolently—or ignorantly, as discussed in an important edited book, *The Dark Side of Creativity*. (Cropley, Cropley, Kaufman, & Runco, 2010). Yet creativity is a resource that can be turned in many directions—even as a knife can be used to make a salad or to commit a robbery. Some believe, further, that all else being equal, the path of creativity can be a positive and ethically distinguished one, most notably, Combs and Krippner, Eisler, Maslow, Moran, Richards, or Sternberg (See Moran, Cropley & Kaufman, Eds., 2014, *The Ethics of Creativity*). Richards (2014) suggests that creative living by its very process nature can help us become better people. Frequently, creators are open individuals, more fully in the present moment, beyond ego, richly aware, less defensive, in touch with their so-called inner and outer worlds—which are in fact intertwined. David Loye showed how Darwin himself in his last writings saw a positive human caring and collaborative trajectory. Creativity can also be central to a spiritual path, as in Zen arts (See Zen).

Higher humanistic path. Abraham Maslow spoke of creativity as characteristic in the “self-actualizing” person, manifesting as creative *person* qualities. Creativity does not necessarily *lead* to a self-actualizing path, although Runco found an empirical relationship between the two. Yet for persons near the top of Maslow’s (1968) hierarchy of needs: “[Self-actualizing] creativity stresses first the personality rather than its achievements....It stresses characterological qualities like boldness, courage, freedom, spontaneity, perspicuity, integrity, self-acceptance ... (and) the expressive or Being quality” (p. 145).

Awareness and meta-awareness. Creativity invites conscious awareness and the cultivation of meta-awareness. Through self-reflection and mindful awareness, there are opportunities to change consciousness, to reflect on war and peace, to hope, to envision worlds of imagination, and to make creative changes in the environment. Manifesting creativity can influence cultural evolution—and help to write the story of the future. One may encounter the “birth of creativity” and one’s higher human potential. Baron, Ornstein, and others spoke of an “evolution of consciousness.”

Epigenetic doors to compassion and deeper relationship. *The Altruistic Brain* (Pfaff, 2015) built on this potential, with proposed ways to switch on helping qualities or prevent these from being turned off (e.g., by trauma). Pfaff noted how Japanese neuroscientist Atsushi Iriki envisioned supporting neural circuits (“neuronal niches”) so that transitory events, such as training in empathy, can be turned into temperamental traits. The science of epigenetics brings further power—such as awe and humility—since it is not always DNA, but also the environment, which activates certain genes.

Empathy, studied in detail by Judith Jordan (2010), is central to “relational creativity,” catalyzing connections, with authenticity and creativity (showing *originality* and *meaningfulness*), in attunement with others. Empathy is the first step in compassionate action. Davidson’s studies of Buddhist monks showed a “sprawling (brain) circuit that switches on at the sight of suffering.” Pfaff noted this could transport “moral compassion into the domain of ‘neuroplasticity.’”

How “Normal” Are Everyday Creators?

People are ever-changing beings, “open systems” in an evolving dynamic world. Yet if only a few have freed themselves to live with process and flow, might this behavior appear odd to those holding more static views of self and the world?

A different view of “self-in-world.” Lives are in motion. A dynamic view is truer to “real life” than a sense of self as a fixed snapshot. A truer view includes profound underlying interconnections with one another, and evolving identity and activity as part of larger complex systems interacting in a milieu of change and surprise. Chaos theory supplies excellent models of sudden change and creative insight itself. It is significant that science (etc)...is now supporting such larger, and profoundly interconnected views. This is also reflected in the Mind-Life Dialogues between science and spirituality, with His Holiness the Dalai Lama, the most recent from Hasenkamp and White. A forthcoming book, *Nonlinear psychology: Keys to chaos and creativity in mind and life*, edited by Schulberg, Richards, and Guisinger, will further bring home to psychologists in accessible (and nonquantitative) ways, the wonders and potential of seeing more deeply into the nonlinear world. Einstein remarked, “A human being is a part of the whole ... a part limited in time and space. [We may experience our] thoughts and feeling as something separated from the rest This delusion is a kind of prison for us.”

Stereotypes. There are many stereotypes of creators with hair askew and bumping into walls—the absent-minded creator. A message sneaks through that creators may still be a little bit “off.” Imagine if identifications shifted more toward being dynamic processes-in-motion, in a world in flux—where creators lived beyond ego, and risked change.

Dynamic Change, Open Systems

In a more dynamic evolving worldview, where change is the rule, and surprise is expected, might there be both a different norm (central tendency) and wider acceptable range (variability)? For example, storm, election upset, economic boom, viral tweet, emergence of a movement (#METOO). Chaos and complexity theory offers ways to adapt. This picture also resonates with a highly creative personality, open, richly aware, flexible, change oriented, preferring complexity, curious, tolerant of ambiguity, risk-taking, surfing the flow of life.

People are *open systems*, changeable beings who shift and change as they breathe in air eat, listen, engage with media and new experiences. Yet individuals also keep a clear integrity and self-maintenance (autopoiesis) so each will still be recognizable.

How well humans accept such change may depend in part on the views of self. If one rigidly clings to a fixed image or view, then altering it may be difficult. If one instead sees life as a process-in-motion, then change is continuous, and life is more like a video, than a still shot. Humans are explorers, not fixed quantities. Creative individuals may well be willing to make mistakes, as part of the quest, allowing adaptation and learning. If a creator occasionally says or does something “weird” in this process—how else might one generate ideas? This range of exploration is, after all, the everyday creative genius of humanity writ large.

Inner richness. Humans are creative and more likely to be aware and mindful while in touch with the unconscious mind, doing willful “deep sea diving” according to Richards, into the psychological depths while, as stated, accessing executive functions to *balance* this.

On the Myers–Briggs Type Inventory, creators turn inward toward intuition more than outward to a sensory world. This inward turn offers the potential to resist accelerating pressures of the age, less outward reactivity, and moving toward higher intrinsic motivation and inner vision. As Thoreau said that if others do not keep pace, perhaps it is because they hear “a different drummer.”

Opening to Creative Living

The topics discussed below are (1) creative life planning (looking without); (2) expressive arts (looking within); (3) mindfulness meditation (awareness, insight, creative catalyst); and some well-needed (4) rest and rejuvenation.

Life Mapping and Creative Planning

Many people expect creative fulfillment through one area, such as professional work, and neglect other areas of creative expression. Yet even Einstein still found time to play the violin. Daily creativity can be rooted in multiple experiences—being a friend, parent, spiritual seeker, life-long learner, and worker in the world. Escalating demands, time pressures and, societal norms requiring immediate attention pull people away and withdraw energy from their creative visions. This leads to exhaustion and “burnout.”

Shifting priorities. Goslin-Jones’s Creative Living Web (Fig. 1) invites exploration into one’s choices for everyday creativity and growth. Choose 1–2 areas to start. Life can then “become the canvas.” For example, one may choose to become more conscious and intentional by prioritizing time for family life, and a creative passion. Focusing on *relational creativity* and family can bring freshness, presence, spontaneity, and originality to each other, honoring relational goals, authenticity, and mutuality. Or consider an environmental passion; exploring the trends of the Cultural Creatives as described earlier, while pursuing green values, sustainability, and vibrant new ways to live.

Creative Living Coaching. Some people will work with a professional coach. Other people develop their own Creative Living Circles or work with a friend. The coaching process is itself creative, motivational, *raises conscious awareness*, and can help work through times of resistance or dormancy (Goslin-Jones & Richards, 2018).

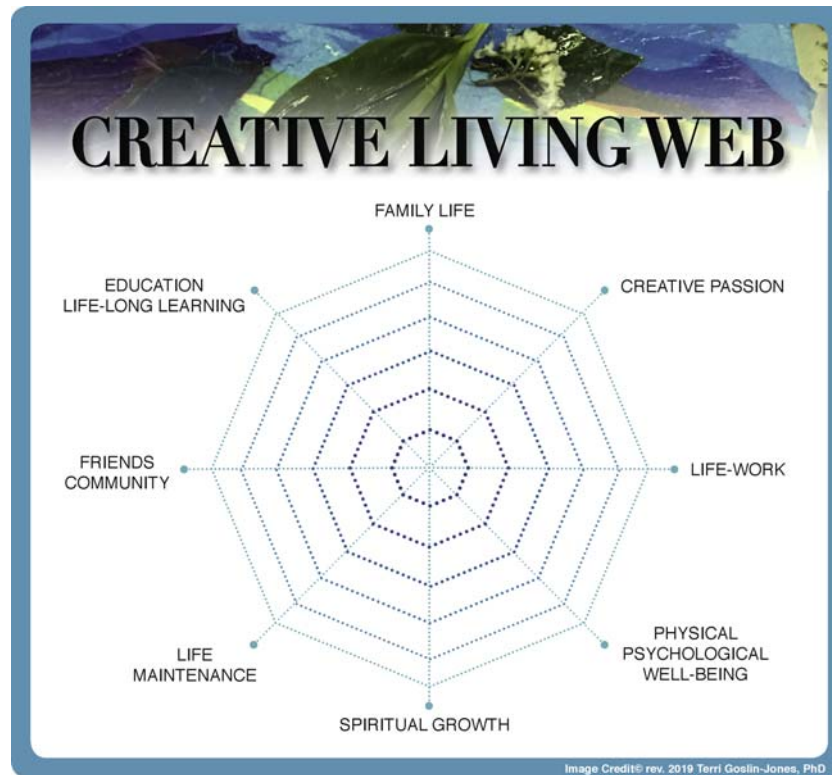


Figure 1 Creative living web.

Person-Centered Expressive Arts

Person-centered expressive arts (PCEA) was originally used in therapy or for social activism and change, and now in coaching to find new insights and empowerment. PCEA was developed by Natalie Rogers, combining Carl Rogers' person-centered philosophy with the interplay of art, movement, sounding, and writing for self-exploration, with others in a safe and supportive environment (Rogers, 2011). PCEA does not require artistic experience. Combining PCEA with Creative Living Coaching offers a process for participants to explore and integrate choices that enrich life.

Although "expressive arts intermodal" coaching sessions are individualized, it is common to start a session with a mindfulness meditation and to include dialogue about the experience at the end. The process offers multiple sensory experiences and opens one's interior world in novel ways. This results in new insights that are incorporated into a Creative Living Plan.

Mindfulness

Mindful awareness is a practice of openly observing one's physical, mental, and emotional experiences, nonjudgmentally and without attachment, with openness, curiosity, and presence in the moment. Mindfulness (vipassana) or insight meditation is central to progress on many a spiritual path, including Buddhist. It also bears interesting connections with higher creativity. Its benefits include reduction of stress, improving attention, boosting the immune system, reduced emotional reactivity, and promotion of a general sense of well-being.

Even a new meditator, after just 2 weeks, shows better focus, less mind-wandering, and improved working memory. Mindful awareness also strengthens activity of the prefrontal cortex and reduces the fight or flight response. Siegel stressed the opportunity to "pause" which makes space for empathy, compassion, and new ways of responding.

Mindfulness practice has the potential to boost creativity-linked openness to experience, "tolerance of ambiguity," and cultivation of nondefensive and nonconforming behaviors. Practitioners may show greater awareness of others and the world at large. Heart and compassion-based meditations can build on this, enhancing empathy and a greater neural attunement with those who are suffering. Some inner-focused mind states, with slower EKG frequencies, as shown by Austin, are not unlike those during insight stages of creativity. Such restful states, and a need for incubation in creativity, as in Wallas's 4-part creative process model of *preparation-incubation-illumination-verification*, support value for everyday creators in taking time for rest and rejuvenation.

Rest and Rejuvenation

The high volume of work and the 24/7 culture cultivates overstimulation and anxiety. This can spiral into physical and emotional exhaustion, problems with sleep cycles, and depression. Some people also experience burnout, depleted energy, exhaustion, and lack of motivation. Even those passionate about their life and work can feel hopeless, drained, or overreactive. In one study, the average person checked their cell phone every 6-1/2 minutes. Some vulnerable people even show brain signatures of addiction to the overstimulation of cell phones and technology.

Many traditions formerly practiced a day of rest and reflection. Families and communities gathered for meals. Everything slowed down. Work stopped. Today, in daily life, taking short breaks is an important habit for encouraging the quality of life and creativity. Energy can be restored by pausing, experiencing silence, and reconnecting with one's inner rhythm. Creativity can be cultivated mindfully with a customized living plan, meditation and rest, toward living a life with zest and passion.

Conclusion and Breath as Metaphor

People are always changing and developing. *This* is human creativity, and the evolutionary process—to explore and to grow, not to preserve some stagnant *status quo*. Individuals are open systems, breathing in food, air, information, life, and energy. People engage the new, stumble and soar; both are important types of feedback. At times, creators may look weird, at other times brilliant. Always, people are in motion and profoundly interconnected. Everyone is truly co-evolving together while co-creating something that they may not yet even begun to imagine.

The Four Areas

The time for risk and creative transformation is *now*. To review:

1. *EVERYDAY CREATIVITY*—Time to see it, consciously to give and receive the meaningful originality of everyday life. As lenses, the Ps of Creativity are guides.
2. *IS IT HEALTHY?* Profoundly, at best, with presence, openness, physical and psychological benefit, e.g., toward resolving conflicts, connecting, mind-body healing, finding higher purpose.
3. *WHAT IS NORMAL?* Diversity, awareness, dynamic change, risk-taking, spontaneity, and presence are qualities to be celebrated. In the future, static conformist norms may seem pathological.
4. *OPENING TO CREATIVE LIVING*. Life is the creative canvas. Creative life planning was explored, aided by expressive arts, mindfulness meditation, and rest and rejuvenation.

Symbol and Metaphor as Summary

One may conclude with attention to breath as metaphor, to breathing in/out, in resonance with an evolving and creative self-in-world, changing, dynamic, alive, visionary, and always active. Research support exists, e.g., from Skarda and Freeman, regarding new mental chaotic “attractors” for scent—spurred by inhalation and formed in exhalation. Buddhist teacher Thich Nhat Hanh suggests, (In-breath) “I am ...” (Outbreath) “Calm and relaxed.” Effects link to mindful awareness, creative states, and chaos and complexity phenomena. Similar to ocean waves, there is a ceaseless process of dissolution and creative renewal. Rieker (1971) offered a pranayama perspective:

Inhalation brings with it the sense that one is absorbing something tangible ... and thereby dissolving it....Now exhalation follows A whole world seems to emerge, fashioned completely from vibrations then that feeling of happiness Thus the pendulum swings from breath to breath, from creation to dissolution and ... back to creation again. (pp. 94–95)

The in-breath resonates with *preparation* and *incubation* in Wallas's model of creative process; the out-breath, with *illumination*, and *verification*. Birthing the new is a big part of the everyday human job—at time a job for “upstarts” and not always socially welcome—however, it may also be a joy and shining challenge in everyday creative life.

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Evolving Systems Approach[☆]

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Glossary

Authenticity A characteristic of a person who demonstrates creativity—"authenticity" literally means "author of values." The person who demonstrates creativity must form new principles, new heuristics, make new connections, and open new worlds.

Constructionism The belief that the person who creates participates in choosing and shaping the surroundings within which the work proceeds, the skills needed for the work, and the definition of the ensemble of tasks—the person must take possession of whatever is needed for the work.

Constructive repetition An important organizing principle proposed by Gruber—the central theme is that creativity, mastery, and meaningful repetition have an important connection. For example, da Vinci sketched over one thousand hands before selecting the version he used for the "Mona Lisa".

Facet Any aspect of a creative case that can be made sufficiently distinct to permit intensive study of it, whether regarding process, product, content, or context.

Initial sketch The creative person frequently begins work on a project by making a quick and crude sketch of the work to follow.

Intrinsic and extrinsic motivation Intrinsic motivation occurs when the considerations impelling a person to do a certain project are inherent in the nature of the work, either as a process or as product. Extrinsic motivation occurs when the motivating considerations are different from the nature of the work. The two kinds, although usually contrasted with each other, are not necessarily incompatible.

Network of enterprise Creative work can be viewed as organized so that enduring enterprises are composed of several projects, and to carry out a project requires engaging in several tasks. The whole assembly of a creator's enterprises is a network of enterprise.

Pluralism An attitude guiding the investigator, welcoming and looking for the many rather than the one or two essentials. Thus: many metaphors, many insights, many mentors, many motives.

Purpose An essential system of the "evolving systems approach"—the creating person requires the ability to see vividly into the future, to have a sense of mission, and to designate a network of viable strategies to ferry one's self to the desired goal.

System The way in which the elements comprising an entity are interrelated or organized into a functional whole. It is usually intended that the elements do not completely lose their identity when participating in such an arrangement.

Introduction

The Evolving Systems Approach (ESA) is both a method and a theory created by Howard E. Gruber. ESA is designed to study and understand creativity. The focus of ESA is for understanding the uniqueness of the individual creative person at work. It involves no commitment to discovering generalizations one can make about all creative people. Its primary aim is to construct an account, both

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analytical and developmental, of each creative person considered and to arrive at what may be called a “theory of the individual.” “Developmental” does not mean an account starting with infancy, but one that starts wherever it is feasible. Fortunately, many productive creators usually leave ample traces of their work. The evolving system comprising the creative person includes three major subsystems: knowledge, purpose, and affect. Creative acts are taken to be outcomes of the functioning of this system, and every episode and every facet of the process of creative work engages all three subsystems.

ESA has the following points of emphasis:

1. The approach is developmental and systematic. ESA views creativity as the result of protracted, hard work over long periods of time.
2. The approach is pluralistic. The person who creates exploits many insights, projects, social relations, and educational sources. ESA identifies three essential, wedded systems that give rise to creative production: purpose, affect and knowledge.
3. The approach is interactive. The person’s work is always conducted in relation to the work of others.
4. The approach is constructionist. The person who creates must reconstruct the elements of a medium to bring a vision to fruition.
5. The approach is existentially, experientially, and phenomenologically sensitive. The person who creates is not considered simply as the maker of the product, but additionally as an active person in a world. He or she is literally living in a medium.
6. ESA proposes that an understanding of creative work requires a conception of the person as an evolving system in an evolving milieu. Each person-as-system is comprised of three sub-systems: organization and application of knowledge, a sense of mission and purpose, and a rich affective domain. Each of these subsystems has a dual aspect; in one way it has an integrated life of its own, in another way it contributes to the internal structure of the person’s other systems.
7. The preferred methodology of ESA is the case study. The case study method has a venerable tradition in psychology. It was employed with great effectiveness by such luminaries as Rudolf Arnheim, Sigmund Freud, Jean Piaget, Gordon Allport, Erik Erikson, Jean-Marc Gaspard Itard, Hermann Ebbinghaus, and Alexander Luria. Each made their ground-breaking discoveries through the in-depth exploration of relevant case studies.

One of the important facets of the case study is the initial sketch, which seems to occur in many if not all instances of creative work. For example, when Picasso began the month long effort that produced the great mural *Guernica*, his first move was a small, rather primitive sketch to which he referred repeatedly in the month that followed. Later, other facets of the creative case study will be discussed. For the moment suffice it to say that each new starting point serves as a search-light that reveals new configurations and as a gyroscope that keeps the creator pointed toward remote goals. In this way, selecting a new starting point permits the creator to maintain a freshness of his or her work. In practice, history and evolution guarantee that such new starts will recur incessantly.

If we do no more than vary the starting point of each study, other changes follow so that each new starting point reveals new facets of the creative process. Consider two contrasting points of view: the psycho-biographer approaches the case with the primary aim of understanding the historical and personal factors that set the stage for the creative process, without actually examining in any detail the creative work itself. On the other hand, the experimental psychologist interested in creativity, in order to have a manageable experimental design, narrows the focus of attention drastically and increases the number of subjects. The psycho-biographer typically pays little attention to the process of creative work; the experimenter relaxes the criteria used in selecting creative subjects (e.g., the more creative half of an ordinary high school class) in order to have enough subjects to complete the experimental design. Taken to an extreme, the assumption underlying much of this experimental research is that everyone or almost everyone is creative to some degree, and we can consequently study the process in the less than great even if our aim is to understand the higher levels of creative endeavor.

By a system we mean a set of distinct components with specified relationships. A simple list of traits is a kind of theory because it proposes to say what is important, but it is not a systemic theory. Only when we examine interrelationships of these members of the system can we begin to speak of systems. Systemic analysis is possible at many different levels, for example, the organism is composed of organs and society is composed of organisms. To choose as one focus of attention a particular level of analysis, or set of levels, need imply no denigration of other levels of their students.

Organization

In the present context, the idea that organization and adaptation are twin aspects of creative evolution could also be described as forces making for stability and forces making for novelty. In the study of creativity, as in all other living processes, there must be continuity and stability.

There is a confederation of scholars interested in creativity, such as genetic epistemologists, Gestalt psychologists, and system theorists. Some researchers in each camp claim superiority for their brand. Each of these approaches can be considered as high-lighting some important aspects of the whole process, their totality providing the context for anyone of them.

One of the cardinal concepts of ESA is “pluralism.” At any given historical moment there are several schematizations available to the person, and they can be selected, composed, and arranged in different ways. The principle of pluralism proposes several schematizations, multiple metaphors, and many enterprises are examined, explored, exploited, redefined, fused, and synthesized with the person’s current and evolving vision and body of knowledge.

At times, the discipline of psychology seems to present a puzzling spectacle. Some of the same controversies crop up in every generation, such as the conflict between holism and atomism, or that between evolution and stasis, or that between sudden intuitive leaps

and incremental change. In 1937, the prominent personality psychologist Gordon Allport wrote, “It is not upon the cell nor upon the single organ, nor upon the group, nor upon the species that nature has centered her most lavish concern, but rather upon the integral organization of life processes into the amazing stable and self-contained system of the individual living creature” (1937, p. 3).

It may be that these repeated controversies stem not from blind commitment to one or another ideology, but from the legitimate necessity to rework fundamental concepts as circumstances change. Allport argued emphatically and at length for the necessity of studying the single case and to point out the various tendencies, in the psychology of that period, to escape from the trap of atomistic, individualistic positivism.

Facets

It is common in psychological research to distinguish between “how” questions and “why” questions. “How” addresses itself to the processes of creative work; “why” asks, what are the underlying reasons for doing it? To a large extent the failure to separate the two kinds of questions has led to profound neglect of “how” questions. An important movement in the study of creativity has been psychobiography, which is the application of personality theory, especially Freud’s, to understanding creative people. A related effort, psychohistory, applies the same range of theories, not to understanding the individual creator, but rather to historical events for which a psychological theory is proposed. Insofar as these approaches delve deeply into the life of a creative person, they are of very great interest. Unfortunately, to a large extent psychobiography and psychohistory have been the occasion for neglecting “how” questions. Insofar as these approaches draw upon the early years of the creator they are forced into undocumented speculations. A third category of creativity research is the psychometric approach, in which tests are administered to large enough numbers of subjects to permit statistical analysis. For different reasons these three methods all avoid studying the creative person at work. On the contemporary American scene there has been a shifting focus on:

- Birth order effects, in which the person becomes creative because of his or her special place in the developing family.
- Bipolar disorder, where the anguish of private life provides the stimulus for creative expression.
- Metaphor, where the ability to see and express commonalities between unlike things is the central ingredient of creativity.
- Great powers of visualization.
- Divergent thinking, the ability or propensity for thinking of unusual responses.

All of these and many more have been singled out as the essence of creativity.

Paradoxically, ESA avoids a singular focus by welcoming all such proposals into the tool shed. However, the uses to which the tools will be put vary from project to project and different creators may accomplish similar ends with different collections of tools. For example, the physicist Richard Feynman solved an important class of physical problems with theoretical tools quite different from those used by others in solving the same problem. Feynman’s method was geometric and the others’ was algebraic. While in this instance Feynman’s method eventually prevailed, the work of the others was also creative. Moreover, the creator does not use one pre-fashioned tool but a collection of them, including some that are invented in the course of work on each project.

From the creator’s point of view, a given facet or facets may be foremost in attention, the vast remainder being the background. The distinction between figure and ground is well known in the psychology of perception. A change in attention may be thought of as a figure-ground reversal. If the figures in question are cherished projects, the creator may experience mixed feelings at the new engagement together with regret at what is left behind. The ground, or context, is so complex and dynamic that new facets are continually appearing. For example, after Charles Darwin published the *Origin of Species* he took up with great vigor questions of physiological botany that had long lain fallow in his network of enterprise. This move brought a certain closure to his work: nearly a century before, his grand-father Erasmus Darwin had written much on botany. Of particular relevance was his long scientific poem, “The Love of the Plants,” which the young Charles Darwin greatly admired but never emulated.

Insight and Problem Solving

There is a widespread belief in the prevalence of sudden insights arrived at intuitively, such insights constituting the genuine article, a creative product. An often retold and celebrated story is August Kekulé’s account of his discovery of the benzene ring, which he made while half asleep on a London bus. However, if his account is read carefully one can see that he had been moving in that direction for well over a decade, and the dance of the molecules that he described was not a unique event, but a mode of thought that he employed in his chemical thinking.

The reverie on the bus must be seen in its larger context, the general nature of Kekulé’s thinking. Moreover, his thinking must be seen in the still larger context of the history of chemistry in the 19th century. Viewed in these lights, Kekulé’s epiphany was not a miracle of intuition, but the product of protracted and directed work by a network interested in structural chemistry (See Intuition).

If insight is not the cause or the embodiment of creative work, what is its role in the creative process? First it should be said that insight, when it does occur, takes a variety of forms. As the culmination of a protracted process it may be a sudden change in awareness, or it may be a gradual shifting in point of view. With this in mind, there is no great need to define insight a priori: the process is

to study the record, note changes, and describe them (sudden or gradual, aware or unconscious, pursued immediately or bracketed for later attention).

Purposes and Motives

A sharp distinction widely agreed upon is made between intrinsic and extrinsic motivation. The former refers to the self-satisfaction sought in actually engaging in creative work. The latter refers to the satisfaction arising out of recognition, prizes, monetary awards, and the power that comes with fame. With regard to intrinsic motivation there is distinction between the satisfaction derived from engaging in the work and that derived from completing it. On the surface it might appear as though extrinsic motives correspond to “why” questions and intrinsic motivations to “how” questions. But if we take the creator’s network of enterprise as a whole as reflecting the totality of his or her intentions, absorption in this set of tasks becomes a powerful motive.

Beginning work on a task sets up a kind of drive for completing it. The question remains open whether this drive is the same as the pleasure in actually engaging in the work. It may well be that in real creative work, both kinds of satisfaction are at work under the broad heading of intrinsic motivation. Meanwhile, it is reasonably clear that extrinsic motivation is also important. Nobel prizes and other blandishments are ever present and highly visible. A plausible hypothesis is that, for whatever reason, at moments when one is not engrossed in the work, extrinsic motivation drives the creator back into it; when he or she is engrossed, the very same extrinsic motives may be a distraction, even a pollutant: intrinsic motivation takes over. In Darwin’s notebooks there are few passages indicating extrinsic motivation, but there are some. And it should be remembered that writing the notebooks was itself part of the work process, a record of activity governed by the task, not of activity governed by other considerations. On the cognitive side belief systems evolve throughout the life history, and on the intentional side motives evolve.

Tasks are not undertaken singly. Each task becomes a member of one or more enterprises. These, taken together, form a network of enterprises, and this network can be thought of as the individual’s evolving organization of purpose. This network of enterprise, once formed, serves to locate any given project within it; at the same time, it represents a large portion of the individual creator’s self-concept. Every task may be said to have a history. A gap, disequilibrium, or unsatisfactory situation is observed; this leads to the undertaking of a task. Some subset of such tasks forms an enterprise. Seen in this light, an insight need not be the solution to a problem; it may be the initial recognition that one exists. Often, the recognition of a problem unsolved, a voyage not yet taken, can produce the thrill of discovery that we usually associate with solution (See Problem Finding).

Skill

Studies of persons who demonstrate creativity indicate convincingly that it is important to develop a level of expertise for a domain as a necessary foundation for subsequent creativeness. Astonishingly high levels of skill account for high levels of creativity. But there are many individuals with great skills who are not very creative. For example, among artists there are greatly skilled copyists and plagiarists who can successfully imitate at least one artist and sometimes many. Such individuals become the plague of museum curators, who for all their expertise sometimes fall victim to artistic fraud. So skill alone is not sufficient for creative work. On the other hand skill is certainly a virtue which may be attainable through practice.

Collaboration

Growing out of the extreme individualism of modern Western society, the picture of the creator as a lonely genius is very widespread, but collaborative processes are also important. For example, there is the well-known case of Albert Einstein and the Olympia circle, three young men who met every week over coffee to share ideas. Thus Albert Einstein, during his years working in the Swiss patent office, was not, as is sometimes suggested, alone in his theoretical quest. He had important collaborative opportunities. Another example is the case of Pablo Picasso and Georges Braque, who together invented and initiated the important movement in art of cubism. Other examples include Vincent van Gogh and Paul Gauguin, Dudley Warner and Mark Twain, Orville and Wilbur Wright, Marie and Pierre Curie, and on and on. Most creative people have significant collaborations during some phase in their creative development, whether it be with teachers, peers or heroes.

Even in the case of the project that is conducted alone, one almost invariably finds that the individual creator is in some kind of fruitful relation with others. Van Gogh, for example, sent his canvases to fellow artists all over Europe and received theirs, providing a rich language for aesthetic discourse, the work itself. Gauguin and van Gogh lived together in Arles, France, working side by side and simultaneously dreaming of a utopian artists’ community. Mythically isolated creators such as Isaac Newton, Emily Dickinson, and van Gogh profited from collaborative relationships. To these examples should be added informal groupings such as the *Salon des Refusés*—artists who were rejected by the French artistic establishment, but nevertheless managed to construct relationships of mutual defense and support.

Conclusion

Post-Grubarians are approaching a well-founded, well-integrated theory of creativity that is both descriptive and prescriptive. Creativeness rises and reaches fruition from the viable pluralism of five evolving systems [1] a rich store of domain-relevant knowledge, [2] the cognitive ability to rearrange and recombine the elements of a domain in service of a synthesis and insight, [3] high levels of motivation to work hard over long periods of time, [4] a sense of purpose, [5] ability to benefit from collaboration and to benefit from exposure to the ideas of other. It is possible to study an individual in detail without raising individualism itself to cult status. Unique people, which we all are, can work together. Creative work always takes place in a multifaceted environment. There is no necessary conflict between respect for the individual and sensitivity to the social nature of all creative thought.

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Expertise[☆]

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Expertise

Expertise refers to the cognitive, perceptual-motor and physiological mechanisms that allow experts to consistently attain superior levels of performance when encountering representative situations in activities in their domains and/or produce new achievements or products valued in the domain of expertise. Webster's dictionary defined an expert as "one who has acquired special skill in or knowledge of a particular subject through professional training and practical experience." Accordingly, typical experts are individuals such as medical doctors, accountants, teachers and scientists, who have been certified as professionals after extended training and have then accumulated experience in their specialty. More recently, the term expert has been expanded to describe any highly skilled performer who exhibits superior achievement after instruction and extended experience in a field. Among those fields, which are called domains, are the arts (e.g., music, painting, and writing), sports (e.g., swimming, running, and golf), games (e.g., chess, SCRABBLE, crossword puzzles, Othello, and bridge), and professional activities (e.g. medicine, nursing, and business). Because the structure of the mechanisms mediating performance of experts in different domains share certain characteristics a single concept, namely expertise, refers to the associated phenomena when they are demonstrated in different domains. Also, experts' superior performance require domain-related experience and thus develop in a similar manner across domains. As the level of achievements gradually increase it is expected that the quality of performance, the value and originality of crafted products, and the adaptation to situational demands will increase and reflect higher levels of mastery and creativity. Thus, high level of expertise and creativity are closely related and both reflect the highest levels of domain-specific achievement.

Overview: Expertise and Expert Performance

The main task for researchers of expertise is to explain how some individuals are able to attain the highest levels of achievement in a domain, and why there are only so few who reach these superior levels. In order to be able to attain very high (expert) levels of performance in domains of expertise, both nature and nurture must be involved. Experts' performances often look effortless, and their most refined and insightful behavior is generated rapidly and naturally rather than being the result of prolonged deliberation. One is thus led to believe that experts excel based on general basic characteristics, such as intelligence, memory, speed and flexibility. It has traditionally been assumed that those general characteristics are impossible to train and thus are determined to a large degree by genetic factors (nature). Everyone agrees, however, that experts must acquire at least some necessary domain-specific knowledge and skill (nurture). The relative importance of nature versus nurture for expert achievement has been discussed for many centuries. A

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couple of questions have been the primary focus. First, how does expert achievement develop and what is the role of instruction and training? Second, are people born with certain characteristics to attain expert performance or are those characteristics acquired as a consequence of training? This entry will briefly review the most important conceptions of expertise spanning the last centuries, then turn to a summary of our current knowledge, and finally outline the implications and connections of expert performance for genius and major creative innovations.

The Traditional Account for Expertise, Expert Performance, and Exceptional Achievement: Innate Talent

Beginnings in the 19th Century: Sir Francis Galton

In his pioneering studies of excellence in 19th century England, Sir Francis Galton found that a very large number of the most valued achievements were made by members of a small number of eminent families. Galton found that as the genetic similarity between relatives decreased, the likelihood that individuals had outstanding reputations also was reduced. To explain how individuals from these eminent families could succeed in such diverse professions as politics, literature and science, Galton claimed that instruction and training were beneficial, and associated with large initial improvements of performance. However, with further experience the associated improvements in performance became increasingly smaller and eventually a rather fixed upper bound for performance was attained. Galton (1869/1979) thought that upper bound was limited by individuals' basic mental capacities which could not be modified through training and experience. The rare occurrence of expert performance could thus be explained by the small number of individuals engaged in the domain who were genetically endowed with superior basic capacities allowing them to succeed. Consequently, Galton and many other contemporary psychologists and educators developed psychometric tests to measure basic capacities of memory, perception and thinking. In those tests the influence of knowledge and prior experience was intentionally minimized. Through extensive testing of children and adolescents, investigators hoped to identify innately talented individuals who, given the necessary resources of training and support, were most likely to achieve high levels of performance.

Is the Importance of Innate Basic Capacities Overrated?

Today, over a century later, it is safe to say that past efforts to measure individual differences in basic capacities did not succeed in successfully predicting future expert performance or even identifying adult experts. For example, when athletes or other experts were tested in the laboratory on how fast they can respond to the onset of a light (simple reaction time), they were not systematically faster than other subjects. The superior speed of tennis players' movements allowing them to successfully return a fast tennis serve must thus reflect an acquired ability to respond rapidly in representative situations rather than a general superiority of speed of neural impulses. Similarly, chess experts can recall nearly all the over twenty chess pieces in a typical chess position (taken from a chess game) after a brief exposure, whereas beginners in chess can only recall around four or five pieces. Yet, if the chess pieces have been randomly arranged, then the advantage of the experts over beginners is dramatically reduced and experts recall is sometimes not even statistically different from the novices. Both the chess experts' and athletes' superior abilities are primarily evidenced in representative situations encountered in their domain of expertise, and therefore the individual differences in their performance in the domain are not consistently correlated with the basic capacities measured in the laboratory.

In recent reviews, the major differences between expert performers and less proficient individuals have been found to nearly always be consistent with specific adaptations acquired by the experts during their lengthy training. This holds true for many anatomical and physiological characteristics of athletes such as the size of their muscles, the size of their hearts, and the flexibility of joints; and for the increased range of mobility of the limbs in ballet dancers and musicians.

Recent research reviewed by Merim Bilalić and Guillermo Campitelli (2018) also showed dramatic differences in the brains of experts with differences reflecting the activities in the corresponding domains of expertise. For example, structural changes in the brains of musicians are correlated with the length or early onset of training. Other adaptations "described by Ericsson (2018) involve" for example the increased thickness of the bones of the playing arm (but not the other arm) of tennis players, or the optimization of oxygen absorption of runners only at certain levels of running intensity. Finally, most physiological adaptations reverted back to normal values once training was stopped or dramatically reduced at the end of athletes' active careers, which is clearly an indication of their acquired nature. However, at least in one instance, namely height, certain that genetic factors independent of experience and training play an important role for the attainment of expert performance in domains, where more height constitutes either an advantage (e.g. basketball) or a disadvantage (e.g. gymnastics).

The incidence of expert achievement in some famous families, such as the Bach family with many famous musicians, is frequently cited as proof for the high heritability of special talents. However, recent reviews of this evidence have questioned such claims. Instead, the early start of instruction of children initiated by parents with musical skill and access to networks and specialized training seem to offer sensible alternative accounts. Because expert performers are so rare, it is very difficult to conduct rigorous studies of heritability. So far, the small number of published studies on experts (i.e. Olympic athletes and musicians) has been unable to document any significant heritability of expert levels of performance. Heritability studies rely mainly on data from individuals who shared the same environment during upbringing (adopted children), and from those who shared genetic material (identical twins, fraternal twins or siblings). Unfortunately, those individuals are surprisingly underrepresented among individuals

reaching expert levels of performance, which makes estimation of heritability of expert performance extremely difficult with those methods.

The Alternative Account: Expertise as Acquired Knowledge and Skill

Acquiring and Organizing Knowledge for Use in a Given Domain

One of the most significant advances in our understanding of expert performance resulted from a direct comparison of the thought processes of experts and less accomplished individuals. In the 1940s researcher [Adrian de Groot \(1978\)](#) gave a pioneering account of the thought processes that allowed world-class chess players to consistently find better chess moves than less skilled players. He instructed chess players of each group to think aloud while they selected their next move for a given chess position. The resulting “think-aloud protocols” revealed that all chess players were quickly retrieving promising moves from memory while examining the organization and structure of the presented chess position. Then, during the process of evaluating these potential moves by searching and planning, even better moves were often discovered. Neither de Groot nor other subsequent researchers found evidence that elite players scored higher on tests of IQ or general cognitive ability or that their speed of processing tasks unrelated to chess differed from those of less skilled chess players. The primary difference between the chess players was that the world-class players were superior in evaluating and reasoning about possible chess moves and generating corresponding moves.

According to the cognitive psychologists Herbert Simon and William Chase, who extended de Groot’s work, expertise is an extreme case of acquired skill. Their view is thus in agreement with general theories of skill acquisition in which knowledge is first acquired and then organized into adequate procedures and actions. With continued practice, individuals become increasingly able to access more appropriate chess moves automatically and speedily through pattern-based retrieval. By recognizing complex configurations of chess pieces, [Simon and Chase \(1973\)](#) argued that an expert can retrieve good moves from his memory of related chess games. Their theory was also able to explain the chess experts’ superior memory for briefly presented chess positions. Also, the availability of complex chess patterns in the long-term memory could explain why they recalled many more pieces from presented positions from actual chess games than less skilled chess players. However, randomly rearranged configurations reduced the advantage of the experts over the less skilled players to a few pieces, because the random configurations would not match the experts’ body of already stored patterns.

Highly organized knowledge was also proposed to be a key factor in expertise involving more traditional, academic activities, such as solving textbook problems in physics. When physics experts (professors) read through a physics problem, they first understand the described situation and when reading the question they can easily generate the steps necessary for computing the answer. In contrast, non-experts (novices such as beginning college students) typically look for the question at the end of the problem first and then retrieve formulas that relate the desired quantity in the answer to the information given in the problem. At that point they can fill in the values and compute the answer. Their general method involves working “backwards” from the requested answer. As one would expect, physics experts not only had more knowledge than novices, but as researchers Micheline Chi and her colleagues ([Chi, Glaser, & Farr, 1988](#)) found, they also organized it around relevant theoretical principles of physics. This allowed the experts to retrieve plans for solving the problem directly as part of their understanding of it. In contrast, the physics knowledge of the novices was poorly integrated and based on superficial appearance of objects, such as pulleys, springs, and inclined planes, rather than deeper concepts. Consequently, the superior ability of Physics experts to reason and solve problems appears to be specific to material related to their domain of expertise. More generally, studies showed that experts in chemistry and social science lacked the special knowledge and strategies to successfully analyze a problem in political science; experts in experimental research were found to be able to design experiments of superior quality only within their particular area of research specialty.

All these results support the general notion that experts’ superiority is closely linked to their superior accumulation of knowledge relevant to the encountered situations during activities in the domain. This suggests the possibility that one could extract the experts’ knowledge and use it to build computer programs, so-called expert systems, which might behave like a human expert. A number of researchers, especially during the 1970s and 1980s, took this knowledge-based approach to expertise and designed methods to elicit the knowledge of the experts, and then described the structure and organization of their knowledge in the specific domain. However, the massive amount of relevant knowledge and methodological problems of extracting knowledge and implementing it in computer models have continued to present major obstacles to the expert-systems approach to expertise.

Challenges to the Knowledge-Based View of Expertise

Once psychologists in 1970s and 1980s became interested in expertise, they searched for domain experts. To their amazement, some “experts,” with lengthy education and extended experience, did not exhibit a performance superior to less experienced individuals or even novices. For example, professional stockbrokers were not found to be consistently superior in selecting investments when compared to random selection of stocks from investment indexes. Similarly, psychological therapists with a PhD and many years of clinical experience were not more successful at helping clients than less experienced therapists with much less advanced training. The most consistent dissociation between level of expertise (indicated by the amount of schooling and experience) and observable performance was demonstrated in many types of expert judgment, especially in medicine and nursing.

With experience, individuals generally increase their performance for a limited time until they have reached an acceptable level of performance. Further improvements beyond this point are unpredictable. For domains such as medicine, nursing, computer programming, auditing and sports, the number of years of work experience has been repeatedly shown to be a poor predictor of

attained performance. Thus, it cannot be taken for granted that all highly experienced and knowledgeable individuals (experts) will actually exhibit superior performance. For scientific purposes, objective evidence for their superior performance is therefore indispensable.

Identifying Experts' Superior Performance

How can superior performance be measured, if mere social recognition of expertise does not always yield scientifically reliable evidence for such superiority? If expert performance is defined as a reliable superior performance in a domain, then the first step is to ensure objectively that all the studied experts actually exhibit this performance under controlled conditions. By defining expert performance as a reproducible performance which is superior to that of most other individuals in the domain, it becomes an observable empirical phenomenon that can be measured independent of any theoretical framework. It now becomes possible to analyze the phenomenon experimentally and compare alternative theories of its structure and acquisition. For example, researchers can try to find out whether or to what degree the performance requires innate talent or if it can be explained with skills acquired through extended experience and training.

Objectively measuring performance of individuals is difficult, and most domains have developed and refined relatively standardized methods for assessing the level of achievement. Virtually every domain focuses on independent and reproducible performance of participants in the domain. In the simplest case, different performers perform the same task, such as athletes running 100 yards during a competition, and the performer with best performance for an event wins. In other domains, such as chess and tennis, the outcomes of many pair-wise competitions allow the computation of a ranking of all the participating performers in the domain. In the arts, sciences, and some sport events, a panel of experts or judges evaluates and agrees on the quality of individual performances or specific achievements. Those achievements can be artifacts, such as paintings, compositions, recordings, books or articles that are ultimately recognized as major creative contributions and innovations. In sum, the evidence from the measurement of expert performance shows a general superiority of experts that need to be consistently demonstrated (reproduced) under many different conditions. Next the findings regarding the importance of experience and practice for attaining consistently superior levels of performance will be discussed.

The Need for Extended Domain-specific Experience to Reach High Levels of Performance

Recent reviews show that long-term engagement in activities of the domain or related domains is absolutely necessary to attain expert performance. When the skill development is studied over longer periods of time as in longitudinal studies (see Fig. 1), there are no sudden increases in performance from one point of time to the next. For example, even child prodigies in chess show a gradual yet steady increase of their performance over time, when they compete against adult players in chess tournaments. Also, expert performers continue to improve their performance long into adulthood. They typically reach the highest (peak) performance of their career at ages from the mid to late 20s for many vigorous sports and from the mid to late 30s and 40s for the arts and sciences. The extended development past physical maturity, illustrated in Fig. 1, implies that experience is necessary for improving performance.

Finally, the most compelling evidence for the necessity of extended experience is how long it takes even the most talented individuals to reach an international level after their start of engagement in the domain or related domains (see Fig. 1). In their influential theory of chess expertise mentioned earlier [Simon and Chase \(1973\)](#) proposed the “ten-year rule”, because they observed that no modern chess master had ever reached the international level in less than around ten years of playing chess. Although there are now several recent exceptions to that rule for young chess players, the fact remains that everyone needs well over five years and nearly everyone more than ten years of concentrated engagement in domain-related activities before winning at the international level in chess. Results from domains of expertise other than chess, such as music composition and a wide range of sports, science and arts, are consistent with this modified ten-year rule. However, the vast majority of individuals who reach such high levels take

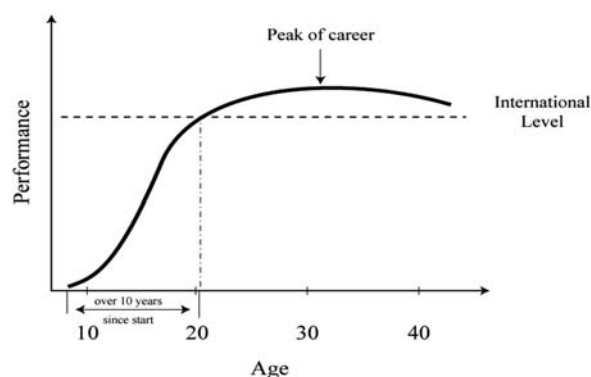


Figure 1 An illustration of the general performance trajectory of elite chess players as a function of age. The international level, which is attained at around 10 years of involvement in the domain, is indicated by the horizontal dashed line.

considerably longer. For example, winners of piano competitions have typically spent over twenty years of concentrated training. In sum, the necessity of active engagement in domain-related activities in order to improve performance in a domain of expertise is well established.

Mere Experience Is Not Enough – The Role of Deliberate Practice and Teachers

When individuals start to engage regularly in a leisure activity, such as playing tennis or golf, or begin to work in a job/profession after finishing school, they initially go through a limited period of relatively rapid improvements. During this time obvious mistakes are corrected. Once they reach a satisfactory level of performance further increases are usually not clearly noticeable. Most people have experienced this phenomenon of a stable level of performance in spite of long-term active engagement in a domain. Consistent with this cessation of improvement, the length of experience in the domain has been found to be, at best, a weak predictor of current level of performance in a wide range of domains, such as sports, medical diagnosis, psychotherapy, and accounting. If additional experience does not automatically change individuals' behavior, what does?

When actions and activities run smoothly, the structure of performance becomes habitual and thus remains essentially unchanged. Even if mistakes occur, such as when a novice tennis player misses a back-hand volley during a game, the other players are not willing to stop the game and give the player chances to train on similar shots. Moreover, this shot is so rare, that the next encounter with a similar shot may well occur unexpectedly and only after hours of subsequent play without such shots. Yet, the same performance could easily be improved by specially designed activities. For example, a tennis player could hit many consecutive back-hand volleys under the supervision of a tennis coach, who could create back-hand volleys of suitable difficulty. When first learning to control a basic stroke, the trainee benefits from simple shots, at least initially. Later, the trainer will challenge the tennis player with less predictable and more difficult shots that are embedded in a representative game context. Optimal training involves exactly this design and presentation of situations that challenge the trainee at just the right level of difficulty. In order to succeed with challenging shots, the trainees have to be able to focus with full concentration so they can identify sources of failures and correct them during repetitions of hitting similar shots. "Deliberate practice" is the term that Anders Ericsson and colleagues (Ericsson, Krampe, & Tesch-Römer, 1993) have coined for such training activities that are designed by a teacher solely for the purpose of improving an individual's performance. When a trainee engages in practice to improve aspects of their game by themselves without the direct help of a coach Anders Ericsson and Robert Pool (2016) used the term purposeful practice to distinguish those activities from deliberate practice. They also introduced the term naïve practice to refer to participation in regular activities in the domain, such as playing soccer games or tennis matches against friends or merely performing the regular work activities in a domain of professional expertise. Contrary to what one might think, active participants in domains, such as tennis, golf and many professions, rarely engage in deliberate practice. Although they recognize that engaging in this type of training would improve their performance, they also find it so much more effortful and less enjoyable than regular recreation or work – that its costs outweigh its benefits. Engaging in a domain activity is usually motivated by its inherent enjoyment (play) or external rewards (work). Yet these activities lack essential pre-requisites for efficient improvement which deliberate practice offers, including training goals, feedback and opportunities for gradual improvement through repetition. Active engagement in a domain does not invariably lead to improvement of performance once some initial acceptable level has been attained.

It is well established that mere engagement in activities of the domain is necessary but by itself not sufficient for attainment of very high (expert) levels of performance. In many domains, promising individuals are supervised by a teacher who instructs them and designs their practice from a very young age. Benjamin Bloom and his colleagues (Bloom, 1985) found out through interviews with international level performers in mathematics, bio-chemistry, music, sculpture, swimming and tennis that they had studied with excellent (master) teachers. In fact, many of these performers or their families had even relocated to be close to a desired teacher or an excellent training environment. Virtually all of them had studied with teachers who either were international level experts themselves or had successfully trained students to reach that level.

Why is it nearly impossible for individuals to guide themselves to expert levels of performance without the help of teachers? Moreover, why does the level of excellence of teachers appear to be so important? Whereas the general cognitive development in children is surprisingly invariant across very different environments and cultures, the development of expertise in domains of expertise, such as music, sports and science, shows large differences across varying cultures and historical times. One of the primary reasons is that domains of expertise have over time extracted and accumulated a body of organized experience in the form of knowledge and produced artifacts. This body of externalized, written-down or otherwise documented, and codified experience can be shared with subsequent generations through teachers, books, and other media. It is no longer necessary for each individual to re-discover pieces of knowledge and methods for doing things, and individuals are thereby able not simply to match but to surpass the level attained by pioneering predecessors. In the 13th century, for example, Roger Bacon argued that it would be impossible to master mathematics in less than 30 to 40 years by the contemporary method of learning through self-study; Bacon was talking about a material roughly equivalent to the mathematics which is today taught in well-organized and accessible form in high schools everywhere.

The necessary role of teachers in mastering any of the arts and sciences becomes apparent when one considers that the accumulation of knowledge and achievements is based on specific shared concepts, symbolic systems, technology (in a very broad sense, e.g., instruments, equipment, materials), and theories with efficiently organized knowledge. Generally, we take the increases in level of expert performance over historical time in science and sports for granted. Given the large changes in technology in these domains, it is difficult to make inferences about the actual changes in skill. Yet, in domains with less changing

technology such as music performance on the piano or the violin, today's performers readily master music that was, by the best musicians in the 18th and 19th centuries, initially considered unplayable. Similarly, in many sports with minimal equipment, such as running or swimming, the highest level of performance attained early in this century is now common place and matched by serious amateurs.

In all major domains there has also been an accumulation of effective methods for teaching the growing body of knowledge and skills. By going through the sequences of training tasks that teachers and coaches have developed over the last centuries, students eventually perform more complex tasks than they thought they would be able to master. Unlike the beginners themselves, the teacher can foresee future skill demands. They know with what method and to what degree of mastery the simpler tasks have to be learned to serve as a solid foundation for more complex future skills. If the simpler skills are not acquired properly, the student might have to completely relearn the fundamental skills. The core assumption of deliberate practice is that expert performance is acquired gradually and that effective improvement of students' performance depends on the teachers' ability to isolate a sequence of simple training tasks that the student can successively master by repetition with feedback and instruction. As mentioned earlier, the individual training tasks have to be difficult enough to lie slightly outside the students' current range of skills, so that the students concentrate on critical aspects and gradually refine their performance through repetition in response to feedback. This requirement of focused attention to individual task components differentiates deliberate practice from both mindless drill and playful engagement. In the best of cases these latter two activities would strengthen the current structure of the performance but not modify it to permit reaching a higher level of mastery.

In many domains, promising children start training with teachers at very young ages. Because of the requirement of sustained concentration, the duration of training is initially quite short – typically no more than around 15 to 20 minutes per day. This leaves enough time for many other more playful but still domain-related activities. Many parents supervise their children's practice by helping them to concentrate during practice, by establishing regular practice patterns, and by encouraging them. With increasing age, domain-related activities, especially deliberate practice, occupy more and more room in the daily lives of future expert performers; by the end of adolescence the commitment to the domain is essentially full time.

Using diaries and other methods to study how expert musicians spent their daily lives, Ericsson and colleagues demonstrated the importance of deliberate practice for attaining expert performance. They investigated three groups of experts differing in their level of music performance. Although all experts from the three groups spent about the same overall amount of time with music-related activities each day, the better musicians spent more time in deliberate practice; the top two groups spent around 4 hours every day, including weekends, in solitary practice. Based on retrospective estimates of past practice times, the researchers calculated the number of hours of deliberate practice accumulated by the different groups of musicians (see Fig. 2). By age 20, the best musicians had spent on the average over 10,000 hours of solitary practice, which was around 2500 and 5000 hours more than the two less accomplished groups of expert musicians; and 8000 hours more than typical amateur pianists of the same age. A number of studies in chess, sports and music have confirmed the relationship between performance and amount/quality of deliberate practice. The broad range of known evidence suggests that most of the individual differences in giftedness or talent can be attributed to differences in practice history, rather than innate differences in talent, especially among children.

Some critics of the benefits of practice have unfortunately viewed deliberate practice as merely drilling with the goal of attaining rapid and effortless automaticity. However, the next section will show that developing expert performance results in acquisition of

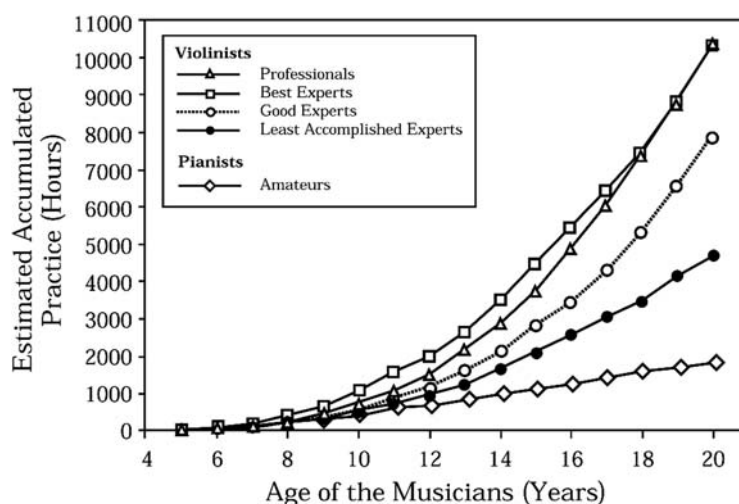


Figure 2 Estimated amount of time for solitary practice as a function of age for the middle-aged professional violinists (*triangles*), the best expert violinists (*squares*), the good expert violinists (*empty circles*), the least accomplished expert violinists (*filled circles*) and amateur pianists (*diamonds*). From "The role of deliberate practice in the acquisition of expert performance," by K. A. Ericsson, R. Th. Krampe and C. Tesch-Römer, 1993, *Psychological Review*, 100(3), p. 379 and p. 384. Copyright 1993 by American Psychological Association. Adapted with permission.

complex mental mechanisms. Experts rely on these mechanisms to evaluate, reason, and improve planning, and also to continue learning without a teacher, essentially becoming their own teachers.

The Structure of Expert Performance

The development of performance of most active individuals in a particular domain is often arrested once an acceptable level of performance has been reached. These individuals want to achieve effortless performance, similar to how they mastered most everyday activities, such as driving a car or typing. In contrast, aspiring expert performers want to improve important aspects of their performance with deliberate practice and continue to do so for years and decades. The key challenge for these performers is thus to avoid a stagnation in their development and instead acquire mental mechanisms that can support continued learning and improvement. What these cognitive mechanisms are and how they mediate performance will be explained in the next two sections.

Cognitive Mechanisms That Mediate Superior Performance

By giving experts representative tasks that capture the essence of the expertise in their domains, it is possible to reproduce their superior performance in the laboratory (Ericsson & Lehmann, 1996). Fig. 3 gives some examples of tasks for which experts' performance in the laboratory would correspond closely to real-life measures of performance used in their domain. In laboratory experiments researchers can instruct the experts to think aloud while they perform a certain task or give a retrospective report immediately afterwards. A recent review by Anders Ericsson shows that in a wide range of domains experts' think-aloud protocols reveal precisely how their superior performance is mediated by preparation, planning, reasoning and evaluation. The first example in Fig. 3 illustrates de Groot's procedure where different chess players are asked to select the best move to a set of unfamiliar positions from published games of elite players. By presenting medical doctors with descriptions of a particular patient's symptoms and asking for a diagnosis, one can similarly study medical doctors' expertise. In both above examples the correct solutions are known to the researcher: We know what move the best chess computer programs would make (these programs are far better than any human player), and we know what disease the patient was eventually diagnosed to have, sometimes from autopsies or advanced tests. The second example in Fig. 3 illustrates how to reproduce superior typing performance in a controlled situation by instructing every typist to copy the same material. The final example shows how musicians can be asked to give multiple renditions of the same piece of music. All three types of expert performance are mediated by different types of acquired cognitive mechanisms. The mechanisms mediating chess and medical diagnosis have many similarities, but the mechanisms underlying expert typing and performing music differ and will be considered separately.

When highly skilled chess players select the best move for an unfamiliar position, they rapidly identify potential moves which are retrieved from among the many moves they have previously stored in memory. To select the best move the players then examine the retrieved moves by mentally planning out their consequences. During this evaluation even world-class players can discover better moves than those they retrieved at first glance. Although chess experts can retrieve acceptable moves seconds after being confronted with a new chess position, their move selection is further improved by planning, reasoning and evaluation. This indicates that performance of experts is not completely automated but remains controlled by increasingly complex processes. The ability to anticipate what consequences a particular chess move would have after several move exchanges increases slowly as a function of chess skill. Chess

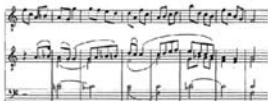
Domain	Presented Information	Task
Chess		Select the best chess move for this position
Typing		Type as much of the presented text as possible within one minute
Music		Play the same piece of music twice in same manner

Figure 3 Three examples of laboratory tasks that capture the consistently superior performance of domain experts in chess, typing and music.

masters have perfected this type of planning to a point where they are able to play chess blindfolded, that is without seeing a chessboard, and relying entirely on their mental image of the chess positions. Experts from other domains reveal similar characteristics.

The processes that mediate the performance of medical experts allow them to extract the relevant information about a patient better than less accomplished doctors. Also, they can entertain and reason through alternative diagnoses so they can identify the best-fitting diagnosis by a process of successive elimination. Thus, at higher levels of performance, individuals have acquired the ability to mentally represent relevant information. This information is made accessible in a fashion suitable for supporting more extensive and flexible reasoning about an encountered task or situation. In most domains, better performers have acquired complex memory skills that allow them to rapidly encode and store relevant information during representative tasks. However, as mentioned earlier, their superior memory skills are developed to encode information related only to executing superior performance in their domain of expertise.

Even the rapid typing speed of expert typists appears to depend on acquired representations rather than mere superior general speed of their nervous system or finger movements. High-speed films of typing show that expert typists look ahead in the text beyond the words that they are currently typing and move their fingers in position for anticipating upcoming keystrokes. In fact, the best predictor of individuals' typing speed is how far they look ahead. Accordingly, in experiments where typists were restricted from looking ahead in the text, their typing speed was dramatically reduced. During the mastery of typewriting the expert typist has acquired the skill to look ahead in the text in order to prepare future keystrokes. Similarly, the rapid reaction times of athletes such as hockey goalies, baseball hitters and tennis players, have also been found to reflect the ability to anticipate future events.

In many instances, the relevant information that performers extract and encode changes as a function of attained level of performance. For example, the primary reason that expert tennis players can so rapidly intercept and return a fast serve is the following: rather than looking at the actual trajectory of the ball once it is hit, they anticipate the ball's path from the preparatory body movements of the server; they are even able to make rough predictions before the server's racquet makes contact with the ball. Hence, the resulting shorter reaction times of experts (as compared to less accomplished individuals) in a domain of expertise are not explained by an innate basic speed advantage but by superior anticipation, preparation, and improved perceptual skills.

Finally, expert musicians are well known for their ability to control their expressive performance of a given piece of music to convey a different musical interpretation. This ability would be difficult to study if the performance changed every time the musicians performed. Laboratory studies have shown however, that if expert musicians are instructed to play the same piece several times in as similar a manner as possible, they are able to reproduce their own performance very accurately from one rendition to the next. Expert artists have a high level of control along with a precise image of their own performance, allowing them to reproduce or vary a performance at their will or to satisfy external requests or their own aesthetic decisions.

In sum, expert performance is not simply characterized by reduced cognitive processing and automatization. In fact, in order to reason about, anticipate, and plan alternative future actions, experts increase the control over their performance and their ability to internally represent it. This control is essential for experts in order to select appropriate behavior. In the case of athletes this could mean capitalizing on an opponent's weakness or taking into account the weather conditions; for the performing artists it may imply adapting to unfavorable room acoustics or synchronizing with other members of the ensemble. Imagine competitive domains, where newly discovered techniques or knowledge constantly change the *status quo* of a domain, or where each tournament takes place with different opponents and in unfamiliar locals. If experts were not able to adapt rapidly to those conditions, the emerging weak points would be exploited by others. Thus, in order to maintain high levels of performance despite any changes in the environment, experts need to possess a flexible, generalizable skill.

Cognitive Mechanisms That Mediate Learning

Attaining expert performance in a domain appears to depend on the acquisition of mental representations that permit control and monitoring of the gradual improvements. Only when the expert performers themselves can image and plan their desired performance, and monitor and evaluate their own ongoing performance, are they able to become independent of their teachers and coaches, and reach their highest levels by engaging in purposeful practice. Developmental studies show that the improvement in representations goes hand in hand with increases in observable performance. Thus, a similar development of representations appears to be the key mechanism that prepares students for adult independence.

Bloom (1985) showed that the training of expert performers can be roughly broken down into three phases illustrated in Fig. 4. After a brief period of playful engagement in a domain (Phase I) some children are introduced to systematic practice in the domain (Phase II). The teachers will present the beginners with simple training tasks and often explicitly guide their students to focus their attention on critical aspects and to make specific changes and corrections. Parents or teachers normally help the children, at least initially, to monitor their performance and to give feedback on how well the training goal was attained. As the complexity of the acquired level of performance increases, so does the complexity of the practice tasks and goals. With further increases in performance, some individuals reach a point where they decide to commit full-time to the domain and make it their professional career (Phase III). Along with the improvement of observable performance, students acquire improved representations to image the desired performance and to monitor their own performance, and they learn how to reduce discrepancies between the two. For example, musicians must be able to internally represent many different aspects of their music performance, such as how a given music performance should sound to an audience, and how to play their instruments to achieve this goal. In this context, it does not matter whether the musician is in the practice room or performing in public. It seems unlikely that a musician who fails to acquire any of these representations would be able to perfect their music performance through solitary practice.

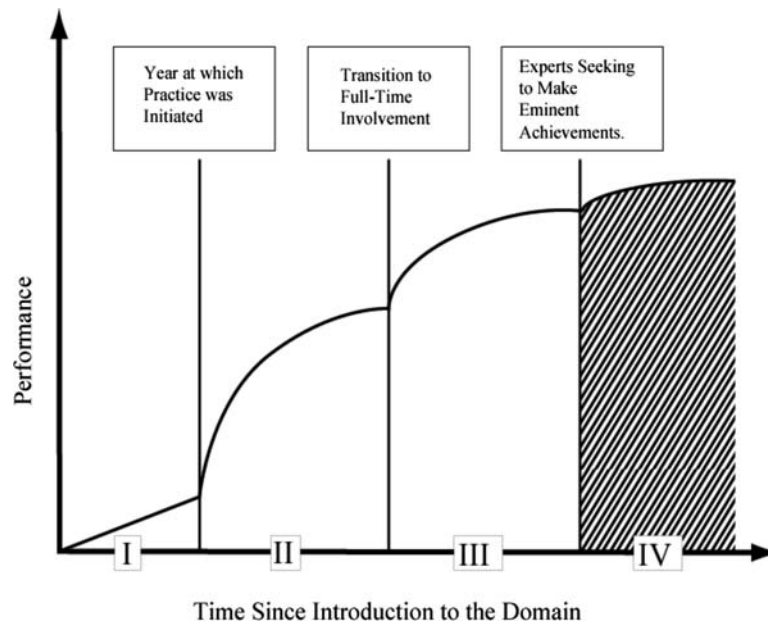


Figure 4 Three phases of acquisition of expert performance, followed by a qualitatively different fourth phase when experts attempt to go beyond the available knowledge in the domain in order to make a creative contribution. From “Can we create gifted people?” by K. A. Ericsson, R. Th. Krampe, and S. Heizmann in *The origins and development of high ability* (pp. 222–249), 1993, Chichester, UK; Wiley. Copyright 1993 by CIBA Foundation. Adapted with permission.

When the expert performers have finally assimilated most of the available knowledge and skills in the domain, they start their professional career. During this fourth phase that Ericsson and colleagues added to Bloom’s three phases, the primary goal is to make a personal creative contribution to the domain. By making those major innovations that permanently change the conception of performance or training in the domain, some expert performers will be able to reach a new level of achievement in the domain.

With the help of their highly developed representations skilled performers can eventually design and monitor their own training to further improve their performance. Studying and analyzing performances and achievements of masters in the field is one important way of doing this. For example, expert chess players collect books and magazines with published games of chess masters. Similar to the laboratory task mentioned earlier, they play through those games move by move and try to predict the next best move the master could have chosen. Any inconsistency between their own prediction and the chess master’s actual move would imply that they overlooked some aspect of the configuration during their planning and evaluation. According to Neil Charness and collaborators (Charness, Tuffiash, Krampe, Reingold, & Vasyukova, 2005), serious chess players spend up to 4 h every day with this type of solitary study (purposeful practice). In general, this form of self-study is theoretically interesting because attempting to copy the model behavior of established masters allows the performers to gradually refine their own independent representations and expand the body of knowledge and skills in a domain beyond what has been accumulated over decades and centuries.

Expert Performance and Creative Achievements

Within the framework of expert performance, the first three phases of training leads to increases in the quality and generality of the aspiring experts’ performance by learning from teachers and experts, thus benefiting from already codified knowledge and insights about performance and deliberate practice in a given domain. During Phase IV a small number experts go beyond and thus redefine the current boundaries of a domain of expertise and generate creative innovations. This view contrasts sharply with the popular view that creativity is reflected in children’s spontaneous behavior and that education and extensive training tend to constrain and suppress creativity rather than enable it. In fact, the expert performance perspective maintains that without training students do not acquire the necessary representations for imaging and generating their products and achievements. To even have a chance to make a genuinely new innovation it is necessary to have assimilated the previously accumulated knowledge and be familiar with earlier, similar achievements. Only extended education will allow an individual to recognize a purposefully generated innovation as being uniquely new and different from prior achievements by others.

As far as is known, the empirical evidence on creative achievement shows that individuals have not been able to make major creative contributions to a domain unless they had mastered the relevant knowledge and skills during a long preparatory period of study and training. Even prodigious children seem to need extensive experience and training, and their creative achievements do not always compare well when judged by adult standards. Not even in the cases of revolutionary innovations by individuals

such as Einstein and Picasso, did [Howard Gardner \(1993\)](#) find that the key creative innovations were generated until the creative individuals had completed their study and mastery of the existing knowledge and techniques (See Evolving Systems Approach).

Furthermore, careful analyses of extraordinarily gifted children have shown that the trajectory of development they follow is similar to that of normal children engaged in the same domains. The difference appears to be that gifted children progress through the stages faster than less gifted children, attaining higher levels of proficiency at younger ages. Detailed analysis of the mechanisms mediating the very high level of performance of children in tennis and chess suggests the same types of acquired mechanisms as those of adults with comparable level of performance. These findings do not support claims of qualitatively different mechanisms in talented children. In music, and also in other artistic domains, researchers have found that the higher achieving children tended to practice more on a daily basis than the lower achievers and typically have more accomplished teachers. This higher involvement along with motivational differences, for which Ellen Winner has argued convincingly, may account for the faster progress of some children over others.

In conclusion, the training of expert performers should not stifle creativity but rather provide the tools to empower the experts to be more successful and effective in their daily work and their search for innovative ideas, especially those few that go beyond what is currently known and done. Equipped with the rich knowledge of other experts' creative achievements through extensive education, the artists, scientists, athletes, or other expert performers can explore possibilities, and perhaps generate major innovations, thus making lasting contributions to their domain ([Ericsson, Hoffman, Kozbelt, & Williams, 2018](#)).

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Expressive Arts

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Glossary

Aesthetic responses are the physical responses that arise in the presence of a creative act or work of art.

Art as Medicine is a healing process in which the person meditates and engages with the images, tells stories about the artwork, dialogues with the art, and dramatizes insights through bodily movements.

Authentic Movement is often used as an improvisational physical movement practice to access internal body sensations and feelings. Unconscious impulses that emerge through movement are expressed in the moment.

Creativity includes four main components process, person, product, and press of the environment. Creativity may lead to a product, idea, object, or behavior that is both original and meaningful to others. Expressive arts can accentuate the creative process by offering an encounter or intense engagement with one's environment and life experience.

Creative Arts Therapists specialize in an art modality such as dance/movement therapy, drama therapy, music therapy, poetry therapy, or psychodrama. Each of these areas has its own set of professional standards and qualifications. The National Coalition of Creative Arts Therapies Associations was founded in 1979 and represents over 15,000 individual members of six creative arts therapies associations nationwide.

Everyday Creativity is a process and a way of life that consists of the capacity to experience the world in original and meaningful ways. This includes a wide variety of human endeavors, including work, family life, community involvement, extracurricular activities, and processes that support life-long learning.

Expressive Arts is a field within creative arts and psychology. Practitioners combine and integrate visual arts, movement, drama, music, writing and other creative processes to foster growth and transformation with individuals and groups for the purpose of providing clarity, creativity, healing, and illumination.

Expressive Arts Therapy is an interdisciplinary, integrative process using psychotherapy, creative arts and forms of creative expression for therapeutic healing.

Expressive Writing when combined with intermodal expressive arts, is a process of freeform writing about emotions and experiences. It supports the integration of insights that arise from using other expressive art modalities.

Imagination is the forming of new ideas and the capacity to be creative. The modalities of imagination include movement, words, visual images, actions, and sounds and rhythms.

Intermodal Expressive Therapy is a specialized and focused psychotherapeutic discipline using verbal and nonverbal communication grounded in the imaginative traditions of the arts. The user moves from one art modality to another within the process of play.

Person-Centered Therapy provides psychological safety for a person to access vast inner resources that encourage understanding and self-directed behavior. The three conditions that foster a person-centered relationship are unconditional positive regard, accurate empathy, and congruence, or the consistency of inner feeling and outer expression.

Person-Centered Expressive Arts is the combination of unconditional positive regard, empathy, and congruence with art, movement, sounding and writing for self-exploration and integration in a safe and supportive environment.

Registered Expressive Arts Therapists (REAT) use the expressive arts in therapy, social work and counseling and may work in hospitals, private practice, or residential facilities for individuals, or for global organizations.

Registered Expressive Arts Consultant Educators (REACE) use the expressive arts in teaching, coaching and consulting and across a wide spectrum of disciplines such as education, coaching, workshops, healthcare, hospice, peace building, organization development, cultural change, non-profit work, spiritual development, and conflict resolution.

Relational Creativity involves bringing authenticity, empathy, presence, originality and personal qualities that permit openness and mutuality. Relational creativity includes ways of manifesting interpersonal, intrapersonal and spiritual potential for oneself and others.

Self-actualizing Creativity as described by Abraham Maslow, fulfills one's humanness and is the ultimate expression of a person attuned to and living the Being Values of truth, justice, and beauty. Some of the aspects of everyday creativity contributing to self-actualization are bringing to a situation one's unique perspective and way of being.

Sounding includes chanting, drumming, music, and vocalization for the purposes of emotional expression, healing, and integration.

Introduction

Expressive arts is an interdisciplinary and arts-based approach for personal growth and social transformation that can be used in counseling, coaching, consulting, education, psychotherapy, and social transformation. Expressive arts is a relatively new field, occupying the ground between creative arts and psychology. Practitioners use the visual arts, movement, drama, music, writing and other creative processes with their clients to foster healing, personal growth, and social change.

Engaging with the arts represents a reclaiming of ancient creative rituals and traditions used to celebrate nature and honor the cycles of life. Art, dance, drumming, music, play, poetry, singing and storytelling have been used for centuries, if not millennia, as ways to express humanity's deepest spirit, honor the milestones of human life and the seasons, and reasons for being alive.

In the early modern era (1930–40) of using creative arts for healing, practitioners focused on using a single creative art for therapy, developing disciplines such as art therapy, music therapy, dance-movement therapy and drama therapy. However, these typically involved some verbal interaction and interpretation. Some patients were unable to participate in talk therapy including individuals with autism, cerebral palsy, speech impairment, or impairment from strokes. New methods were needed.

Unlike healers who specialize in one art form, expressive arts practitioners mix the visual arts, movement, drama, music, writing and other creative processes. Expressive arts combine forms of creative expression for many purposes: self-awareness, therapeutic healing, everyday creativity, understanding the psyche/soul, individual and collective growth, community building, and social transformation.

Pioneers in Expressive Arts

Some of the pioneers in expressive arts are Paolo Knill, Shaun McNiff, Arthur Robbins, and Natalie Rogers. Paolo Knill was trained as a physicist, musician, and later as a psychologist. He was an author, a performance artist, and co-founder of the European Graduate School, based in Switzerland and Malta. Two of his major contributions to the field included the philosophy of taking the *whole being* into the learning process and using the performing arts in his work as a psychologist. Knill developed "intermodal expressive therapy," which engages imaginative realms through the process of play while the person moves from one art modality to another. For example, the experiencer would share a painting and poem in a small group and then add movement and sound.

Intermodal theory proposes that each art form contains the seeds of other art forms, such that a drawing may inspire a person to dance the emotions that were expressed in the drawing. Intermodal expressive therapy uses both verbal and non-verbal communication between the client, the art process, and the therapist. When the transition occurs from one art form to another, the client's experience can be amplified, clarified, and understood in new ways. An example of an intermodal transfer is sharing a painting and poem in a small group before adding movement and sound to enhance the imagery (Knill et al., 2003, 2005).

Shaun McNiff is a painter and teacher who established one of the first intermodal expressive arts training graduate programs, at Lesley University in Cambridge, Massachusetts. McNiff, who began as an art therapist, teaches about the interconnectedness of the healing power of the arts, art as medicine, the creative process, and imagination. After an image is created, a participant might paint a picture, pause to have a written or oral dialogue with it, then return to working on the painting. This process peels back layers of defenses or blocks to understanding. Emotional responses and messages from the body are then incorporated into the painting.

McNiff emphasized being aware in the *present moment* while engaging in the creative process, as opposed to breaking the art process into a specified sequence of moving from one art modality to the next. He rejected an overreliance on rationalism and psychopharmacology. Building on Jung's concept of active imagination, McNiff recommended dialoguing with images through painting, movement, and storytelling as a way to activate one's creative energy. He has been a prolific author on the topics of art-based research, art as the source of healing, and the creative imagination (McNiff, 1992, 2015).

Arthur Robbins is a psychologist, depth-oriented therapist, sculptor, teacher, author and co-founder of the Pratt Institute Creative Arts Therapy program in New York. Robbins used the arts to explore and define concepts such as play, creativity, holding and

containment, transference and counter-transference. He referred to expressive arts therapy as the cohesion of three different levels of consciousness: the mind, body and spirit.

Although Robbins's framework was originally based on art therapy, he argued against the limitations of using the single modality of visual art. He asserted that there was strength in using a creative arts approach with multiple art forms including dance/movement, puppetry and music. He recommended that even though an art therapist may cultivate a specialization in one art form, such as drawing, the therapeutic training should stretch into multiple areas of creative expression and focus on the creative process. He advised that the creative process should be customized for the client and not be limited to one therapeutic model. Robbins believed that "every art therapist must possess and develop the soul of and sensitivity of an artist" (Robbins, 1994, p. xiii).

Natalie Rogers was a psychologist, artist, teacher and founder of the Person-Centered Expressive Therapy Institute in Santa Rosa, California. She began integrating the arts in her private practice with children and adults and entered the field of expressive arts through her work in play therapy.

After working as a psychotherapist for twelve years, Rogers began working with her father Carl Rogers in 1974 on a series of 10-day person-centered workshops. She quickly found that sitting through long verbal sessions was difficult for her and other participants, and that additional outlets were needed to work with the pain and anger that can emerge in group therapy. Natalie invited smaller groups of workshop participants to use experiential processes with art, movement and psychodrama to relieve physical tension, cultivate somatic awareness, and to explore deeply held emotions. This experimentation was the beginning of her life-long contribution: integrating the person-centered philosophy with the multi-modal expressive arts process she named the *Creative Connection* (Goslin-Jones and Herron, 2016a).

To design a *Creative Connection*, Natalie Rogers recommended using a variety of art materials and creative experiences in a multi-modal process with individuals or groups (Rogers, 1993, 2011). Person-centered expressive arts guidelines are offered to participants at the beginning of each session to foster a safe and supportive environment. Trust is established by extending guidelines such as 1) Everything is an invitation, 2) Feelings are a source of creative expression to be channeled into art-making, 3) There is no right or wrong way to make art, 4) Be aware of your feelings and body and take care of yourself, 5) Expressive arts stirs up feelings; crying, sounding and expressing emotions can be extremely helpful (Goslin-Jones and Herron, 2016a; Rogers, 1993). The person-centered expressive arts approach is a flexible structure that invites participants to make personal choices using a variety of modalities such as art, movement, sounding and writing for the purpose of accessing inner resources for greater self-awareness.

Expressive Arts Process

There are numerous ways for an expressive arts session to be offered. The book *Integrating the Expressive Arts into Counseling Practice* presented a collection of field-tested expressive arts interventions used by counselors and educators (Degges-White and Davis, 2018). Various counseling theories were discussed and relevant expressive arts interventions described, including goals, population, materials, and instructions. The authors explained how using intermodal expressive arts to develop a tangible product (ex. collage, image, sculpture, story, painting or dance) may lead to greater self-awareness.

Applications With Individuals

An individual expressive arts session might start with a brief 5-min mindfulness meditation. Then the participant may be invited by the EA professional to move or gesture in spontaneous ways that convey feelings or physical sensations. When the movement feels complete, the facilitator invites the participant to express his or her feelings using art supplies. This activity can be as simple as using the non-dominant hand with crayons, or it may be making a collage, clay sculpture, or sock puppet, or finding objects in nature that represent feelings, desires or challenges. Next, a writing prompt may be offered, such as "I am, I feel, I need," to encourage the participant to capture the experience in words. Finally, there is an opportunity to share the creative process orally with the facilitator.

A therapist who works with mentally ill adults living in transitional housing and the homeless gave the following account:

Peter; a 30-year-old, homeless man with whom I had developed a tenuous relationship, seeing him only about once every six weeks, over a period of a year. One day I found Peter sitting behind a building in a drainage ditch where a group of young homeless men hung out during the day. On this day Peter was alone and appeared to be very depressed. I asked permission to sit beside Peter and he consented. After sitting quietly for several minutes, Peter replied that he had recently found out his father had died. He was feeling tormented that he had been unable to be by his father's side as he died or attend his funeral.

I asked Peter if he would like to write or draw a letter in chalk, reassuring him I would help him sweep the drawing away so no one would see it, if he wished when he was finished. Peter asked if he could create a tribute to his father, so I found a deserted parking lot and provided Peter with a bucket of chalk. He created a very large tribute taking up over three parking spaces. Peter drew his father and the items he felt were important in their relationship including a bible, several guns, military images, and his family home. The drawing of his father was over seven feet tall, the guns were six feet in length, and all other items were oversized, except for his family.

Would this creative intervention make a difference in this man's life? The therapist said that the session brought about:

a major turning point in the therapeutic relationship. Peter demonstrated this remarkable turnaround by his willingness to meet with me more often, take his medication regularly, and by successfully moving into transitional housing. Three years later, Peter was married and is still married after 5 years (Goslin-Jones and Herron, 2016b, p. 99).

Applications in Group Settings

Expressive arts are also used in a group format for education/training/self-awareness and community development. The group might consist of a class of students, a group of co-workers, or a community agency. Various art materials and experiences are offered. The intermodal use of movement, art-making, sounding and writing provides a way to work through conflicts and to discover creative solutions. When expressive arts are used with a group, the session may range from 90 minutes to week-long workshops. This is an example of an individual's experience in a group setting:

While I was in the expressive arts experience, we used art-making to create a portrait of our body. The session was called "Wisdom of the Body." We later moved and danced to the portrait and then reflected on the experience. I was able to process a lot of information about my relinquishment at birth and being adopted, and my adopted parents' divorce when I was 10. I processed layers I had no clue were there and because of that I felt like I could fly at the end of that course.

Goslin-Jones (2010), p. 168.

Those interested in reading more vignettes should consult *Creative Connections with Groups* (Rogers, 2011), which included articles from 26 expressive arts practitioners. The practitioners work with children, adolescents, adults and elders on issues such as addiction, anger, Alzheimer's/dementia, cancer, cultural bridging, developmental disabilities, eating disorders, empowerment/self-esteem, grief, refugee children, stuttering, spirituality, professional development for therapists, teacher education, victims of crime, mindfulness for veterans, and unleashing creativity in the workplace.

An expressive arts participant may find the practice so worthwhile that he or she continues it after the session ends. Another participant reported,

Expressive arts have probably been most helpful on a day-to-day basis. If I feel angry or unhappy, I observe my feelings and then take my journal and scribble, draw, or create a collage. It may be just 10 minutes. It is a way of defusing tension. It is a way of getting back in touch with myself and noticing if something doesn't feel right in my body.

Goslin-Jones (2010), p. 167.

Expressive Arts and Social Change

The book *Art in Action: Expressive Arts Therapy and Social Change* (Levine and Levine, 2011) presented a collection of expressive arts interventions used to foster social change. Case studies included a clinic for displaced Iraqis in Jordan, Bosnian refugees in Slovenia, and HIV-positive women in prison. Collaborative poetry writing, dance, and drama were used with survivors of war to address the hardships they experienced and to help them find new ways of working together. Outdoor spaces that had been destroyed were reclaimed and recreated into art spaces and community galleries. Expressive arts were employed by Natalie Rogers (1993) to build bridges across cultures in Europe, Mexico, Japan, Philippines, South America and the former Soviet Union.

Research

Prior to 1980, there was more extensive research in art therapy, but minimal research in the use of intermodal expressive arts. During the past 10 years, research on expressive arts has increased on a wide variety of topics, as indicated in Table 1. Such research has been

Table 1 Expressive arts research and professional publications

Years	Dissertations (ProQuest)	Master's theses	Peer rev journal articles (web of science)	Peer rev journal articles (PsycINFO)	Books (WorldCat)
1960–69	2	0	0	0	13
1970–79	3	0	4	2	76
1980–89	21	1	10	13	88
1990–99	32	15	14	32	224
2000–09	57	23	30	60	249
2010–18	103	52	76	149	421

published in doctoral dissertations, master's thesis research, peer-reviewed journals, and many books. As demonstrated in [Table 1](#), professional publications in the field have vastly expanded in number since then. The following data was collected by the present author using the search terms, "expressive arts or expressive art".

Expressive arts are used for community-based action, coaching, conflict-resolution, decision-making, everyday creativity, grief work, innovation, personal growth/empowerment, psychotherapy, stress reduction, product development, self-actualizing creativity, team-building, and workplace transformation.

As is true in many fields, there is no single archive that includes all research published on expressive arts. Additional expressive arts research may be available in other areas such as anthropology, education, and sociology. Combining art-making, music, movement, and writing with other creative processes is a powerful way to support health and well-being. The arts have been applied in mental health, education, the workplace, and the community. A major advantage is that a person needs no artistic experience to use the arts, because it is the *process* of art making and not the product that releases blocked emotional and physical energy. The client is offered creative processes to develop his or her own innate creativity and this facilitates new forms of self-expression. Words can be limiting, and expressive arts invites a multi-layered communication using art, movement, sound, and writing. This creative process also includes reflection and improvisational skills and is a way to be present with oneself and with other group members to access and re-ignite creativity.

Expressive arts increase self-awareness that facilitates physical, emotional and spiritual well-being ([Goslin-Jones and Richards, 2018](#); [McNiff, 1992](#); [Rogers, 1993, 2011](#)). It can also serve as a catalyst for increasing emotional intelligence or relational creativity. Relational creativity involves bringing authenticity, empathy and presence to oneself and to others and, when effective, can deepen relationships and connection. Expressive arts can be a bridge or pathway to access one's intuition and creative capacity.

For example, a research participant named Carmen said she accessed preverbal knowledge by engaging her body in movement, activating her senses with art-making, and using musical expression.

You end up discovering that you know things you did not know that you knew, because they are preverbal. After you participate in an expressive arts experience, you complete the process by writing down your words and stories and then you share it verbally. You have brought up wisdom from a deep place where it was preverbal; you didn't know that you knew it. Suddenly there it is and now you can talk about it.

[Goslin-Jones \(2010\)](#), p. 92.

Expressive arts can also be helpful to those with limited awareness. Sandy was 78, diagnosed with dementia and depression, residing in an eldercare residence. Sandy was offered expressive arts to enhance her social interaction and support her emotional well-being ([Goslin-Jones and Herron, 2016b](#), p. 95).

After two individual sessions the therapist introduced music, movement, and art. While sitting in her chair, Sandy and the therapist would both raise their arms together in the air, rotate their wrists in circles, and sway their arms to Sandy's favorite music.

After these movement exercises, the therapist would invite Sandy to choose art supplies such as brightly colored paper, cut out shapes, magazine images, pastel chalks or crayons, and proceed to make art. In the first art session, Sandy had difficulty choosing any color of paper, shapes or images to make her collage. The therapist would slowly go through the different colors, asking if she liked red, blue, green, yellow, until Sandy pointed to the one she liked and that color paper was used for a canvas.

As the sessions progressed, Sandy was able to quickly choose the supplies she wanted. She glued her own images onto the paper and learned how to enhance her collage with chalk pastels and crayons without assistance. As the sessions progressed, Sandy's mood became more positive and she looked forward to each session. After 4 sessions, Sandy began sharing her artwork with other residents, asking how they liked her art. Other residents liked her art and began to join Sandy's expressive arts sessions.

Research studies indicated that expressive arts processes helped participants develop abilities in artistic expression, communication skills, compassion, conflict resolution, decision-making, empathy, everyday creativity, intuition, listening, mindfulness, problem-solving, relational creativity and greater wholeness ([Goslin-Jones, 2010](#); [Goslin-Jones and Herron, 2016a,b](#); [Goslin-Jones and Richards, 2018](#)).

Risks and Challenges in Using Expressive Arts

One of the primary requirements for participants in an EA experience is a safe environment free from criticism or interruption. Some community environments or workplaces may not be conducive to engaging in free forms of expression or offer a supportive environment. Art-making and expressive arts processes can easily stir up emotions, and in many organizations feelings are not openly

expressed. In group situations, some participants may dominate, others may feel inhibited, while yet other participants withdraw because of creative blocks.

The sensitivity, self-awareness, and skill set of the facilitator are critical. The facilitator needs to provide healthy boundaries by establishing and modeling respect, personal responsibility, non-judgement, empathy, and trust. If an expressive arts experience triggers highly emotional memories that have been buried, the facilitator may need to moderate the pace and offer multiple ways to process strong emotions, especially in group or workplace situations.

The candor and authenticity that can emerge from expressive arts may feel threatening to friends and family members. Some people dismiss expressive arts and feel that it is a waste of time, because it can feel playful and it is hard to measure results. Finally, it is challenging for some students and clients to sustain an expressive arts practice after the formal education, therapy, or group experience ends. However, even though there are some risks to using the arts, the research participants who used expressive arts in one study stated that these benefits greatly outweighed the risks (Goslin-Jones, 2010). As the field continues to grow, further research into impacts on other populations and circumstances will be important.

Development of the Field

During the 1980's and 1990's, the field of expressive arts expanded as educational programs emerged and therapists introduced the use of multi-modal arts into their work. After experiencing challenges with the for-profit *National Expressive Therapy Association* (NETA), several professionals in the field decided to create an alternative, non-profit organization that was membership-based and led by volunteers. The co-founders, Jack Weller, Anin Utigaard, Stephen Levine, and Phillip Speiser, named the new non-profit the *International Expressive Arts Therapy Association* (IEATA®). It was a significant change to include the word *arts* in the title and to make the framework for the non-profit organization interdisciplinary, using the arts, creative process, and psychology as integral aspects of the professional work and philosophy. The expressive arts field expanded to include therapists, educators, and consultants.

IEATA was founded in 1994 and hosts international conferences, provides professional guidelines, ethical standards, and a professional network to bring expressive arts into the world for “growth, healing, communication, and collaborative learning” (<https://www.ieata.org/>).

It was important to the founders and members that using different art modalities in an intermodal process (visual art, drama music, movement, poetry, and writing etc.) be recognized within the field of Creative Arts Therapy. This also led to developing guidelines and credentials for professionals in the field that are now used in the expressive field around the world.

The Registered Expressive Arts Therapist (REAT) credential is designed for those who use intermodal expressive arts in therapy, social work, and counseling. The Registered Expressive Arts Consultant Educator (REACE) credential is designed for those who are trained in and use intermodal expressive arts in coaching, cultural change, education, healthcare, hospice, organizational development, peace building, social transformation or spiritual development.

The International Expressive Arts Therapists Association (IEATA) established professional guidelines and a rigorous review and registration process. For example, there are supervision hours required for the registered expressive arts therapist (REAT); however, supervision hours are not required for the registered expressive arts consultant/educator (REACE). IEATA has discussed the limitations of having *therapist* in the title of the professional organization. When IEATA was formed in 1994, individual and group therapy were the primary applications of expressive arts. Currently expressive arts therapy is being used across many populations, organizations, and for social transformation and hence, the designation for the Registered Expressive Arts Consultant/Educator (REACE) was devised.

The International Expressive Arts Therapy Association established ethical guidelines that are available at www.ieata.org. Ethical guidelines cover informed consent, qualified competence, moral and legal standard, research, public statement, confidentiality, welfare of the client, collegial relationships, special considerations for expressive arts work, and non-ordinary states of consciousness. All Registered Expressive Arts Consultants Educators (REACE) and Registered Expressive Arts Therapists (REAT) agree to abide by the highest standards of professional practice and to adopt values and goals that support and advance the expressive arts community.

Future of the Expressive Arts Field

There are opportunities and uncertainties in the field of expressive arts, as there are in every field. For example, is there a primary expressive arts discipline that can be taught and mastered in integrative expressive arts? How can an expressive arts practitioner develop competence in such a diverse field? Even though a practitioner may specialize in one art form such as music, movement, writing, or visual arts, he or she cannot have expertise in all of the arts.

Should expressive arts practitioners use the existing theoretical foundations in the fields of psychology and creativity, or establish a distinct field? Who determines requirements for credentials in the field? As the field of expressive arts becomes more well-known, numerous certificate programs emerged around the world with a wide variety of philosophies, educational processes, and costs. Some expressive arts programs are accredited through a host university and students receive graduate credits and degrees. Other programs are not accredited, and the student pays tuition without knowing if the certificate that is awarded will be viewed as

a genuine credential. Funding challenges may exist for the students, educational institutions, and the organizations who want to incorporate expressive arts into their programs.

As the field continues to evolve it is important to stay grounded in the history of using intermodal creative processes to foster healing, personal growth and social change. With tested applications in counseling, coaching, consulting, education, psychotherapy, and social change expressive arts has a promising future. Engagement in expressive arts can awaken our innate creativity and activate our imagination and intuition, leading to the development of our higher human potential.

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Failure

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The Importance of Failure

Although creativity is often thought of as a good thing, and failure as a bad thing, in reality, they are interlinked. Failure cannot be avoided when being creative and can in fact be a positive force in driving human creative endeavor. The world's most successful and creative people have failed while on their journey, and often done so spectacularly and painfully. This chapter therefore examines the place of failure in creativity.

Failure in a creative endeavor can be encountered at many points in the process. Such failure is often linked to differences between the creator's perception of the work and the perception of others. The environment also has a place in failure and creativity. The creative industries are used in this entry as a significant example, but it is also noted that creativity and its role in innovation is important to a wide range of organizations. In particular, the difficulties of supporting failure without damaging reputation are exposed. On the basis that not everyone (or every organization) will respond to failure equally, the entry looks at the characteristics which suggest a more effective response. These include individual traits, behaviors and attributes ranging from knowledge to resilience. It is also the case that the environment plays a significant part in enabling a creative response to failure and so the entry finally examines how creative response can be fostered by organizations and networks.

The Meaning of Failure in Creativity

Before examining the relationship between failure and creativity, a definition of failure must be reached. Most people would be familiar with the example of a feature film (which involves significant creativity) being termed a "flop" if it failed to achieve box office success. However, the reasons for such a commercial failure (though difficult to highlight exactly) could be attributable to issues at various points in the process ranging from a poor script near the start, through to misguided directing while filming or ineffective marketing post-release. Incidences of failure and the opportunity to respond creatively are therefore more widespread than initially thought.

To illustrate this point further, the practice of sculpture (which most people would consider to be highly creative) can be used. If a sculptor accidentally broke-off the head of a sculpture, this could be considered a failure in applying appropriate techniques. However, if the same sculptor completed the work without such a mishap, but then failed to sell it, it could still be considered to be a failure. These failures occur at very different points in the process, but they both present the opportunity and need to respond creatively - the only other alternative is to give up. The point at which failure occurs in the process, and the nature of that failure means that the response is likely to be varied, hence the need for greater insight into failure and creativity.

Failure is usually defined in three ways - a lack of success, the neglect of some action expected (for example, when something was not completed on time), or something ceasing to work (such as a computer malfunctioning or a business collapsing). Failure and how it fits into creativity can be considered in relation to these three definitions.

First, to consider the "lack of success" definition, the example of the production of a "creative" artifact such as a painting or a piece of music can be used. Here, if the ultimate result were to be badly received critically or commercially, it would be seen to have failed. Crucially though, the creator may have considered it a huge success up until that point - the failure may therefore come as a surprise

and initially, it may seem that their labor has been in vain. If he or she is still committed and have the resources (time, ideas etc.) however, the creator can respond creatively to find another way forward. In doing so, the hope is that their effort so far is not completely wasted and that the likelihood of success will be greater.

To illustrate the second definition, the same creative practitioner may fail to deliver the required artifact to their client or audience when it is expected. This could be due to any number of problems in the production process. Importantly though, the creative practitioner would know that they were going to fail – it would be no great shock. Indeed, their conscious or unconscious actions during the production process may have contributed to the failure. They may argue that events have taken the better of them or some unforeseen problem occurred, but again, their inability to respond constructively would have played a part in the failure.

Taking the last definition, the creative practitioner may experience the failure of a crucial piece of equipment while making the artifact, or the business that has commissioned the work may go bankrupt partway through the process. Although this type of failure (of an inanimate object or organization) seems out of their control, there are still options to respond creatively to take the work forward. Examples could include adapting to using a different piece of equipment to that which has failed, or changing the work sufficiently so that it can be sold to a different organization.

Time, context, and the perception of creative work also have a significant bearing upon creativity. In terms of time, many services or products which have been realized using a creative process begin to fail as society and technology moves forward in new directions. An obvious example would be in the creative practice of car design – an older design considered good in its day may now fail to adhere to safety or emissions standards, or fail to sell because of better competition. In this particular field of practice then, the car designer needs to respond creatively to the failure of previous generations to develop a product which is future-proof. Otherwise, any new design is also likely to fail in some way. Context and perception are also a crucial part of the picture. For example, a creative product may sell well in one part of the world but for cultural or economic reasons, be a commercial failure in another. Such complexities can make responding to failure (or the potential of failure) with creativity somewhat challenging.

While the focus of this chapter is on failure, it is useful to place this in the context of a definition of creativity. Over the years, many authors have sought to define creativity, including [Runco and Jaegar \(2012\)](#), [Csikszentmihalyi \(1997\)](#), [Robinson \(2009\)](#), and [Robinson and Aronica \(2009\)](#). While the audience for such authors' work is slightly different, they agree that the common definition of a creative idea is one which is new and has some usefulness. So while the obvious focus of creativity is often on artistic or cultural pursuits such as music or painting, this need not necessarily be the case. In fact, the "new" and "useful" ideas which creativity generates can be valuable in many spheres including some which many people would not immediately think of as "creative". Whatever the field however, the crucial question is how a person or organization deals with the inevitable failure as part of their aim to generate ideas which are "new" and "useful".

Environment and Its Role in Failure

The definitions of failure have shown that although failure can take place through the actions (or non-actions of the individual), the external environment also plays a significant role. Therefore, although many people, irrespective of the type of work they do have some chance to be creative, the creative industries will be used here as they provide the most striking illustration of the role played by the environment.

In the creative industries, work is constantly appraised, shaped, and consumed through the function of gatekeepers or what authors such as [Bourdieu \(1984\)](#) term as "cultural intermediaries". Though not producers of creative work themselves, cultural intermediaries bridge the gap between creators and consumers and therefore decide what will be successful and what will fail. While there are differences between the various parts of the creative industries, some common practices exist. For example, an author will need to have their book commissioned by an editor, and a musician seeking a recording contract will need to be contracted by an Artist and Repertoire (A&R) Director. These cultural intermediaries do not commission work "cold" however. Instead, the creative practitioner will bring a creative artifact (for example, a book manuscript or music recording) to them for the purposes of securing a legal and commercial agreement. Up until this point though, they may well have been working creatively in isolation.

A number of factors therefore contribute to the potential for failure in this scenario. First, now there is often a significant "gap" between when a creator undertakes their work, and when it is consumed and this can give rise to a potential disconnect. Taking musical performance as an example, prior to the invention of sound recording, a musician's only outlet would be performing to an audience, from which the response would be immediate and palpable. Capturing a musical performance on record changes this dynamic, as the musician has no audience reaction upon which to build their creativity. Instead, they rely on the cultural intermediary to "reflect" and communicate to them what they think will be creatively or commercially successful. The same situation exists in acting when comparing a theater performance with acting in a film. In these examples, there is more vagueness as to what is viewed as "creative" and this increases the likelihood of failure. Secondly, the creative industries have a poor record on being able to forecast what will be successful and what will fail commercially. Taking the example of the music industry, a very high percentage of recordings produced make a loss, and it is the small percentage of successful ones which are essential to subsidize the failures. It is therefore an industry which demonstrates a poor ability to forecast what will be successful, the result of which is that commercial failure is common. The same can be said for many other example sectors such as film and television production, book publishing, art or theater. A final factor is that the creative industries are very attractive to potential workers who gain high

levels of personal fulfillment due to the nature of the work. The greater the number of potential workers seeking financial support or rewards for their work, the greater is the likelihood of failure for anyone seeking to start or sustain a professional living in a particular sector of the creative industries.

When focusing on the “where” of creativity, the work which Csikszentmihalyi (1988) published on the systems level of creativity is particularly significant. Csikszentmihalyi outlined how creativity sits at the interface between the individual, and what he calls the field and the domain. The field is made up of a specific community of practice (including its gatekeepers) and the domain is where the knowledge and culture exists. The manner in which these elements relate to each other is summed up:

For creativity to occur, a set of rules and practices must be transmitted from the Domain to the Individual. The Individual must then produce a novel variation in the content of the Domain. The variation then must be selected by the Field for inclusion in the Domain

Csikszentmihalyi (1999): 315.

Failure to be admitted into the domain by the gatekeepers therefore means going back to the drawing board and coming up with another creative approach, idea or solution. To do this, the creative practitioner may need to draw upon the domain for the required knowledge that will then feed into the solution – it may therefore be the case that they need to acquire greater knowledge of the domain. The important aspect to note however, is the influence of the domain on the work produced, and the influence which the field (in the form of gatekeepers) has on whether work is successful or not – this is termed as “situated creativity”. Csikszentmihalyi is not alone however, and other authors have also noted the manner in which creativity needs to find support and influence. Two notable examples of this are Sawyer (2006) and Sternberg (2006). Contrary to what most people immediately think, both of these authors point out that getting ideas to be accepted is often more difficult than coming up with ideas to start with. This is also why Simonton (1995) added persuasion to the existing four P’s of creativity.

Many people have the potential to be creative in their work and everyday lives, and so it is important not to just focus on the creative industries. Creativity is also of value to the wider business world and is the process through which the novel ideas which form the basis of innovation are made possible. This often takes place where individuals rather than working in isolation, collaborate to come up with “new” and “useful” ideas. This tends to bring even more complexity to the situation and indeed, opportunities to fail in many ways (sometimes centered on the individual, other times on the organization). This concept of group creativity and how the environment is key is examined in detail by Paulus and Nijstand (2003). Here, in the first part of the book they focus on how group creativity takes place and how it can be inhibited or supported in any number of ways. The second part deals with issues associated with the environment and context, in overall acknowledgment that group creativity cannot be adequately understood without due consideration of where it all takes place. Creativity is also linked to innovation and entrepreneurship. However, unlike the creative industries where “critical” acclaim for creativity can be seen as valuable, in the wider business world, creative ideas need to have a more straightforward grounding in utility, and contribute to the “bottom line”. In order to have this type of functional utility, creative ideas need to provide an appropriate response to some sort of problem or gap in the production, marketing or logistical processes of an organization. As noted earlier, in meeting such a need, the creative response can be to a failure resulting from decisions made in the past. However, the means to achieve it lie in the organization as a whole (rather than just the individuals in it) being creative. It therefore involves organizational rather than individual creativity whereby a complex social system and organizational structure comes into play.

Although failure is an inevitable part of creativity, unsurprisingly, organizations (just like individuals) prefer success to failure. In fact, companies and organizations do much to foster an image of success – from the high consumer rating of products and services through to how the business is run. For companies quoted on the stock exchange in particular, a public perception of failure can have a massive negative effect on share price, the ability to borrow money or even the potential to attract new employees. This could lead to the situation where employees and managers ignore or avoid failure for fear of attention from the organizational leadership or the external world. This is a mistake however, because as authors such as Sitkin (1996) noted, failure plays an essential place in an organization because it creates recognition for risk as well as a motivation to change (most likely involving creativity). Sitkin also noted that organizations need to be aware that not all failures are equal and so should therefore take steps to actively “manage” failure. The most effective outcomes occur from failures which have the following five characteristics: (1) They result from thoughtfully planned actions that (2) have uncertain outcomes, (3) are modest in scale, (4) are executed and responded to with alacrity (eagerness), and (5) take place in domains that are familiar enough to permit effective learning.

Responding to Failure With Creativity

Individual Response

In recent years, failure as a route to success has gained attention in the academic literature as well as in more “mainstream” publications that aim to encourage their readers not to fear failure. For example, Matson (1991, 1992) has written extensively about Intelligent Fast Failure and how taking such an approach can enhance innovation and creativity in a variety of organizational environments including schools, Universities and workplaces. In essence, Intelligent Fast Failure is a process of trial and error taken until a satisfactory solution is found. An example of a publication with a broader target is that of Harford’s (2011) book, *Adapt: Why*

success always starts with failure. Harford argued that the sheer bureaucracy of the modern world bogs down and slows up innovation, while bad practice and poor decisions are allowed to flourish in dysfunctional markets. The argument is that if things were allowed to fail, and people admitted their mistakes, the result would be better practice and more innovation. What these authors highlighted in their different ways however is that failure needs to be accepted as inevitable (and even attractive), in order for creative solutions and ideas to be produced.

Examples of people who have responded to failure effectively range from those of history through to the present day. For example, Edison, the inventor of the light bulb produced 10,000 prototypes before the one that worked was discovered. He noted "I have not failed. I've just found 10,000 ways that won't work. I am not discouraged because every wrong attempt discarded is another step forward." Similarly, Henry Ford said, "Failure is only the opportunity to begin again more intelligently." In more recent times, James Dyson, one of the world's leading designers and industrialists produced 5127 prototypes of his first vacuum cleaner before arriving at the effective solution. From the world of popular music, Nile Rogers has stated that "the way I cope with failure is to make another hit". While these people obviously demonstrate the ability to just keep going despite the setbacks, there is likely to be more to their approach than that. They are responding to each failure with creativity where many others would just give up. This gives rise to the question as to why some people and organizations creativity turn failure into success, and why others are less able to.

Dealing with failure and still being creative is far from easy, so the question firstly arises as to what type of person is most likely to be able to do this. According to [Amabile \(1989\)](#), and [Furnham and Bachtar \(2008\)](#), the traits associated with creativity are divergent thinking, openness and preference for challenge. These traits apply directly to how someone deals with failure. For example, divergent thinking involves formulating as many solutions as possible rather than following a convergent thinking approach which would tend to involve working through incremental, logical and clear steps. Engaging in divergent thinking means an individual is not bound by approaches which they or others have taken before (successful or otherwise), and instead, thinking of novel new ways of doing things. When experiencing failure, taking the same approach will simply result in further failure so the greater and more varied the number of options, the better. To do this, the individual must draw upon their own experience and knowledge and so the greater this is, the more likely it is that a solution will be found. In addition, a greater level of knowledge and experience will also provide confidence in going forward.

The person experiencing failure can also look to other fields for ideas or inspiration, and it is here that the concept of openness arises. Having openness means that they will be able to synthesize approaches from different fields and apply them to the problem in hand. This demands critical thinking skills not only to take in the information and process it, but also to apply it in a flexible way. Last, and perhaps most crucial to dealing with failure is the preference for challenge trait. By definition, a challenge is something which must be overcome with thought, ingenuity and effort. A given challenge could involve overcoming the failure of others or the non-functioning of existing systems. Not being able to overcome the challenge could also end in failure and so, a preference for challenge is intertwined with being able to engage with failure or the potential of failure. Certainly, the type of person who falls at the first hurdle and avoids challenges is less likely to be creative. This is because they are unable to draw upon their own expertise to deal with failure, and not open to looking for ideas and inspiration elsewhere in solving the challenge.

[Sternberg \(1985, 2006\)](#) noted that creativity depends upon six distinct but interrelated resources: intellectual skills, knowledge, thinking style, personality, motivation and environment. Intellectual skills and knowledge can be thought of as the "mental" resources, which can be used to find creative new ideas and solutions. In dealing with failure as part of a creative process then, the greater the intellectual skills and knowledge the person has, the more likely they are to be able to move forward creatively. These internal resources which are drawn upon can be developed deliberately through personal improvement and learning such that the level of expertise is fit for the challenge. However, the more experience (including that of failure) a person has, somewhat ironically, the more they can develop their expertise. Taking the example of an inventor who constantly fails to get each prototype to work but carries on to the next one, with each failure, it is not only the prototype which gets better, but also, the inventor's capability to a point where they become more expert than anyone else in the field.

Sternberg's concept of thinking style resonates with how divergent thinking supports creativity. The manner in which someone's thinking style can help or hinder their approach to failure in the creative process is therefore pivotal. At one extreme, a divergent thinking style is flexible and is based on a heuristic approach to the problem. This type of thinking style which looks for innovative ways to solve problems is more likely to be creative and solve problems. At the opposite extreme, a type of thinking style which is rigid, narrow, and fixed upon prior approaches is unlikely to find creative ways to solve problems and is more likely to fail.

Personality, motivation and environment are also important elements. Personality characteristics pertinent to dealing with failure include resilience and confidence that creativity can be used to find new solutions. The quotations from inventors and industrialists show their unwillingness to allow failure to stop them. However, because of their intellectual skills and knowledge, such people possess the necessary confidence in their own ability to solve problems and move forward. This may be because they have found their way through problems in the past, and although they do not presently have a solution, are confident that they will come up with one. Additionally, the further through the process of developing a product, idea or service they are, the more expert they have become and this can also be a source of motivation as they near the end with increased confidence.

While motivation to be creative is important, the concept of resilience goes beyond this as a predisposition for dealing with failure. Resilience is the manner in which an individual (or an organization) "bounces back" from a setback, problem or barrier. Creative practitioners can experience frequent and significant setbacks, and similarly, those who seek to be creative within an organization may find their ideas are rejected or not valued. Even the most creative or talented person may give up at some point depending upon how resilient they are.

Interestingly, the value in creativity in developing resilience has gained attention by researchers in the field, including Metzyl and Morell (2008). Here, the pursuit of creativity is explored as a way to deal with trauma or setback by providing a way or release, escape or distraction. It is suggested that creativity can be used to not only solve problems, but also, that deep down, engaging with creativity can be a way of processing rejection, failure or even traumatic life events. This does however depend upon the focus of the creativity. If the creativity is related to solving a problem or dealing with a failure, then it could be considered to be moving forward and finding a solution. However, if creativity is merely an “escape” from a failure or problem, then the problem will remain unsolved. As Metzyl and Morell noted, this may help the person engaged in creativity personally, though this may not be related to a work challenge. Taking the example of the creative industries, the result of this may be that the domain rejects the work while in the wider business world, the creative results may not find support, as they do not contribute to the bottom line.

Environmental Support for Responding to Failure Creatively

As this entry has outlined, creativity does not really take place in isolation as the environment has a crucial role. It follows therefore that the environment has a crucial role with respect to failure. For the individual “creative”, failure is often decided upon by the complex systems of cultural intermediaries and shifting markets. For someone employed within an organization, it is the organization’s structures, processes and culture which have the potential to accept failure as part of the process and support creativity.

For the individual creative practitioner such as a musician or artist, considerable problems can occur due to working in isolation and this often contributes to the likelihood of failure. Many people are familiar with artists such as Van Gogh who were not particularly successful during their lifetime, and yet kept going, only to receive critical acclaim after their death. Alongside obvious talents, examples such as these demonstrate resilience and commitment to their work, and the ability to not be discouraged by failure. The individual creative practitioner actually has considerable potential to “shut-out” the world and can get to the end of the process of producing a creative artifact without much interaction. This does however, increase the likelihood of failure and by doing so, the creative response is more of an ignoring of, rather than constructive response to failure.

Instead, a creative response to failure has to take account of the fact that today, the production of creative goods takes place within the creative industries with its complex system that serves to define what will be successful and what will fail. The creative practitioner may get little in terms of prompts, information or support to mitigate against, and respond to, failure. However, at some point, the system will present them with failure to which they must respond, drawing upon their own resilience and capability. While failure could be of their own doing, the role of the domain in deciding what will be admitted and therefore successful is crucial. It follows therefore that an understanding and appreciation of the domain is vital. The domain can be difficult to understand or infiltrate though, so the creative practitioner needs to find ways of mitigating against, and of working with, failure. One of the ways of doing this is by being a part of networks or guilds made up of their peers. Such “organizations”, however informal, can support the creative practitioner by being a source of knowledge, information and prompt as to how to go about their work. Rather than working in isolation then, the work can be better aligned to what the domain will find acceptable for admission. For creativity, the environment is also a source of ideas, inspiration and solutions to problems, and such creative networks or guilds can provide this. Mitigating against the risk of failure through isolation is particularly important today where more creative workers utilize new technology to work remotely. This is because the problem of working remotely using new technology is actually twofold – firstly, likelihood of failure is increased due to the isolation and secondly, engaging in creativity can be more difficult because of the lack of social interaction in which creativity best takes place.

As was noted earlier, many people (other than creative practitioners) have the opportunity to be creative in their work, and organizations need to value creativity for its role in innovation. As failure plays a part in this, organizations need to accept its inevitability on the precept that it will ultimately lead to innovation. In a practical sense, this can mean allowing time for employees to think, providing support with resources, communicating encouragement and allowing freedom from criticism of failure. This will not just allow individuals to generate creative ideas, but also enable relationships and collaborations to do the same. Clearly, this situation is complex because an individual is unlikely to want to be seen to fail in front of those with whom they are unfamiliar. Failure may also be seen badly in the eyes of those higher up in the organization. For these reasons, there is considerable danger in employees coalescing around innovations with a lower risk factor rather than those they know to be riskier. At the other extreme, employees who are highly creative may involve themselves in risky projects for their own personal satisfaction whereas ultimately, these bring little economic or logistical benefits to the organization. Again, unfocussed creativity may fail in its contribution to the organization because it is not a direct response to a problem or gap in the production, marketing or logistical processes of the organization.

It follows that the culture of the organization has considerable influence on how failure is tolerated and therefore how much creativity flows from it. Organizations which are rigid may well not be interested in creativity and may also not tolerate failure. The organizational structure, lack of feedback or guidance, lack of budget, lack of recognition, and amount of red tape or bureaucracy can be behind such a situation. Such organizations may therefore foster behavior which inhibits creativity with people who are not keen to be inquisitive or question assumptions and instead, exhibit a tendency to conform. It does also, of course depend upon industry sector and how far through any given process creativity and failure occurs. For example, many software companies are known for releasing new versions of their software which are not fully developed. Instead, they rely on new users to find bugs that they then go back and fix. Here, the creativity of the programmers responds to the failure discovered by users. In many cases, new features not thought of by the programmers themselves can be later included. By way of comparison however, the Pharmaceutical industry would take a different view (as do the regulators governing their work) and only sell products that they believe to be relatively risk free as the ramifications could include a degradation of health or even death in their users.

Some factors under the control of the organization can interestingly foster or inhibit creativity. For example, a lack of resources could work either way. While creativity generally needs resources (whether in terms of time or tangible support mechanisms), authors such as Runco (2004) have noted that a lack of resources can force creativity to take place. It is a similar situation with competition. Generally, competition stimulates creativity. However, if intense competition in the marketplace makes new ideas, products or services obsolete before they make back their investment, the creativity to produce such things could be discouraged. Here, fear of failure actually inhibits creativity, at least in the short term.

The concept of resilience and how it relates to failure also applies in an organizational context. Here, it reflects the organization's ability to absorb and respond actively in order to make the most of unexpected and disruptive events which could threaten its survival into the future. The rapid change in technology and global disruption means that organizations face more turbulence than ever, and many scholars noted that creativity is essential in responding successfully to such turbulence. Richtnér and Löfsten (2014) examined this concept in depth, specifically how a capacity for resilience influences creativity. Based on their findings with a breadth of organizations, they noted that in order to be resilient and for creativity to be fostered, organizations need to address two aspects. Firstly, adequate skills are needed, knowledge must be present and (as cognitive resources) these must be developed over time. This enables the right person or resource to be matched to the problem in hand. Secondly, trust, respect and collegiality (as emotional resources) must be present. The authors acknowledge however, that it is much easier for an organization to develop structural resources than the "softer" aspects such as trust and collegiality. Overall however, the conclusion is that organizational resilience is found to be positively related to organizational creativity.

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Families[☆]

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Glossary

Authoritative parenting A style of parenting characterized by high expectations and rules as well as freedom and flexibility. Dialogues about the rules and boundaries are also encouraged.

Child-centered families Families who spend a vast amount of time, energy, and resources on developing their children's interests and enriching their experiences. Some parents want to insure that the children they perceive as gifted receive early instruction in their domain of giftedness.

Complex families Families characterized by a balance between integration (i.e., seeking support and warmth) and differentiation (i.e., seeking independence as well as developing one's own identity and interests).

Eminent creativity Characterized by such originality and novelty that it is recognized by a certain field as being culturally significant, and being remembered for altering a domain.

Enriched environment Home environments characterized by books and multitudes of other intellectually stimulating resources. Parents typically read to their children early on, hold serious discussions with them, and take them to interesting places such as museums, zoos, and theaters.

Everyday creativity Characterized by originality and uniqueness as well as meaningfulness and usefulness in day-to-day life. It might not revolutionize a field, but it makes a difference in the creative person's life.

Resilience The ability to function competently in a stressful situation that threatens development and adaptation. It has also been defined as the ability to recover from trauma.

Introduction

Families are lambasted or exalted in numerous works of arts including plays, novels, songs, and operas. They are depicted mercilessly or indulgently in paintings. Playwrights, novelists, songwriters, composers, and painters hold particular views of families that may or may not be reflected in their work. Certainly, their families shaped their creative evolution. For example, Mozart's father resolutely turned away from his own (admittedly flailing) career and devoted himself almost exclusively to his son once he recognized the boy's talent. Similarly, Picasso's father allegedly pledged to stop painting once he realized that the 13-year-old boy was better than him. He then dedicated much time and energy to his son's artistic education. Freud's mother adored her son and the family life was strictly structured around his early work habits.

Whether these eminent creators would have become equivalently eminent had their family circumstances been different is as intriguing as it is unanswerable. However, the influence of the family on the lifelong development of creative talent does not show just uniformly pleasant childhoods. In part for this reason families have received much theoretical and empirical attention.

[☆] *Change History:* August 2019. Mark Runco updated the text throughout.

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That is the focus on this entry. It reviews family characteristics and the role of stress in the early lives of creators. It also examines the set of responses that creative children develop as a reaction to stress and how this very set of responses shapes creative development. This entry ends by presenting a framework that ties together the overarching themes reflected on in this article. Even though it is generally accepted that creativity requires the input of both nature and nurture, the hereditary aspects of creativity are outside the scope of this entry (see Piffer and Hur, 2014).

Parenting Style

Parents who are warm, involved, caring, and yet willing to give their children the freedom to explore at their own pace are more likely to have creative and imaginative children. Parents of creative children who scored high on creativity tests and were labeled as creative by their teachers seem to be less overprotective and more tolerant of the hostile feelings their children may direct toward them compared with parents of other students. Naturally, many children labeled as creative do not necessarily become eminent creators. Parents of creative children are, in general, well educated, successful in their careers, and self-confident. Moreover, parents of creative achievers tend to be relatively egalitarian, and creative young people themselves are less concerned about following rigid sex roles. Thus, they also seem comfortable considering activities and fields that are not typically associated with their gender. Empirical work by David Harrington supported this idea with correlations between family life, creative talent, and psychological androgeny (a balance of masculine and feminine traits).

Families favoring independence are likely to have creative children. Indeed, highly original children are encouraged to be independent from their earliest age (Albert & Runco 1989). Parents who value independence are also usually receptive to unconventional thinking and to particularly imaginary play, such as involvement with imaginary companions and imaginary worlds. This form of play is associated with various forms of creativity in adulthood. Thus, it seems that the child rearing style of creative achievers' parents tends to be less conventional, and more flexible, which promotes originality, and freedom of expression. Although they might appear lax, rules and expectations are firmly in place as well within these families. This style of parenting is sometimes referred to as authoritative, and is characterized by the presence of both boundaries and flexibility. Boundaries give children a sense of security, while flexibility offers children the freedom to discover, explore, and play, all of which have been associated with problem solving. The Authoritarian style of parenting is somewhere between authoritative (where parents make all decisions) and laissez faire styles (where parents are largely uninvolved).

In sum, parents of creative children have a particular approach to parenting. Likewise, they have a specific approach that is conducive to the development of creative potential, as evident in their interactions with their children, their home environments, and the experiences they choose for their children.

Family Background

Creative individuals tend to have encouraging parents who were likely to be financially and culturally privileged. Finances, and more generally, socioeconomic status (SES), is relevant to creative development because it influences the material resources available to the child, as well as whom the child is exposed to, how much travel he/she engages in, and which institutions the child visits (Dai et al., 2012). There is a discussion in the literature that is consistent with the idea that "necessity is the mother of invention," the implication being that a lack of resources may sometimes stimulate creative thinking. But data are more aligned with the first view, where resources are readily available.

Notably, SES is related to education. Parents' level of education impacts what is discussed at home and how. It also carries the message that education is highly valued in the family. Another aspect of SES is economical. Families with significant resources may be less concerned about gearing their children toward high salary careers and are willing and able to support nontypical interests. SES may have an effect on richness of experience, which has been related to divergent and flexible thinking.

Creative achievers generally come from enriched, child-centered environments. Parents support and encourage children and are dedicated to the development of their child's creative talent. The climate at home is very stimulating, with books and a multitude of other resources readily available. Parents make a conscious effort to regularly expose their children to various venues illustrating the richness and diversity of the life of the mind. Parents take their children to zoos, theaters, concerts, museums, and libraries. Creative achievers' parents respect learning and the pursuit of intellectual and artistic interests. They tend to be creative themselves in addition to broadly curious. These parents often love challenging debates, and are typically busy in cognitively demanding activities. They engage their children in serious discussions about complex matters. Parents also regularly read to their children from their earliest childhood. These parents respect their children's opinions and consider what the children say and do as important. Hence, they regularly collect their children's work and highly value it. They also encourage their children to be independent, and foster model values such as discipline and hard work.

Thus, through interesting books, enriching experiences, and stimulating conversations, creative children develop a certain understanding about the world that lays the foundations for the acquisition of further knowledge. A wealth of knowledge is indeed considered a prerequisite for many creative endeavors. Moreover, a child centered environment builds the child's self-confidence and makes him or her feel valued and loved. Harrington's research, mentioned briefly above, also found an association between a home life with *unconditional positive regard* and the development of creativity. However, a child centered environment does not

preclude that tensions exist between parent and child, or that the child's life might be stressful because of other types of adversity of various degrees of seriousness. One type of stress is the presence of siblings.

Birth Order

In some families, particular children are clearly favored over others. This can lead the less cherished offspring to express their frustration creatively. Their creative efforts may attract attention and allow these creative children to distinguishing themselves from their siblings. Indeed, birth order plays an important role in determining family expectations and resource allocations. Robert Albert described birth order, as well as family or sibsize, as family structural variables. He contrasted these with process variables including things like parenting style or discipline style. Birth order has received more attention than any other variable. It can also establish which child will occupy which niche within the family, including who will be deemed the 'creative one.'

There is a lack of consensus within the literature with regards to creativity and birth order. First born appear to be more creative based on some studies whereas others claim that it is later born who hold this merit. Another position is held by scholars who suggest that family size, age differences, and sex differences are the mediating factors in the birth order-creativity equation (Bender et al., 2013). Frank Sulloway, in *Born to Rebel*, argued that birth order affects the various stratagems that siblings concoct in order to win parental approval. Indeed, the overrepresentation of first born among creative achievers could be attributed to their special status within the family. As first and only children, they received all the attention from their parents and enjoyed all resources available. They are thus motivated to hold on to this privileged position when siblings arrive. They do so by identifying with parental authority and accepting the power structure within the family. They often act as surrogate teachers to younger sibling(s) to further please their parents, which gives them experience with responsibility and maturity. First born typically demonstrate early focus, and are more academically and achievement oriented than later born.

The exceptionally high number of last born among eminent creators might be due to birth order as well. As the youngest in the family, the last born also received notable parental attention, perhaps because he or she is the last child the parents will ever have. Last born, precisely because they are later born and never received undivided attention from parents, tend to be indifferent to power and to question and challenge the *status quo*. Middle- and last-born children tend to be more rebellious than first born, who have clear conventional and conforming tendencies. Indeed, last- and middle-born must carve a distinctive place for themselves within the family sphere, and must experiment to discover their niche. Hence, they adopt a personality style and field of study that are distinct from that of both first born and parents. Sulloway demonstrated how often middle born children have led rebellions and attributes this to their experience at intentionally going in a direction that is different from others. Given that first born children tend toward the conventional direction, that leaves the unconventional niche for middle-born children, and this often supports rebellion and creativity.

Later born are thus much more likely than first born to accept and embrace new and revolutionary ideas (i.e., Darwin's theory of evolution). Whereas first born do not support radical revolution, later born do not back conservative ones. Likewise, first born demonstrate their creative brilliance within a field's accepted paradigm, while later born exhibit their creative virtuosity outside the *status quo*. First and last born also differ in the expression of their creativity through the two dimensions of openness to experience. Indeed, Sulloway proposed that birth order relates closely to this personality trait so that first born use the intellectual dimension of openness to experience (i.e., perceptiveness, curiosity, and culture) and later born the nonconformist dimension (i.e., risk taking, unconventionality, originality, and independence).

There are also domain differences: first born are disproportionately represented among eminent scientists, and tend to excel in the physical sciences, possibly because problems are well defined within this field. Numerous eminent scientists are last born as well, although less so than first born. Last born are more altruistic than first born, and thus likely to excel in domains that are socially oriented. They often prefer the biological and social sciences, where problem finding plays an essential role. In addition, last born tend to work simultaneously on multiple projects that often cross boundaries. When they win the Nobel Prize, it is in domains such as peace and literature, whereas first born tend to be honored for their contributions to the sciences.

Birth order therefore seems to influence the personality of siblings because it shapes the approach they select to win parental favor. Thus, for Sulloway, birth order ultimately contributes to the ways first and last born reach creative eminence. Creative children may also face much more taxing situations than competition with siblings. (See Birth Order).

Stress, Trauma, and Adversity

Creative and academic achievers (meaning, children who do well at school) present very different family profiles. The latter's families tend to be more stable, child centered, and favoring a conventional style of parenting. The former tend to come from troubled family backgrounds, where the relationship between family members is tense, the parenting style unconventional, and the likelihood of parental dysfunction high.

Indeed, studies on the childhoods of eminent individuals based on material culled from biographies and autobiographies reveal adverse family environments. Victor Goertzel and Mildred Goertzel examined the home environments of 400 eminent individuals, and then 317 additional ones. Forty-four percent of the entire sample of 317 eminent people experienced a stressful childhood, including a majority of the actors, novelists, composers, musicians, explorers, athletes, philosophers, and psychologists. For

example, as children they were raised by single parents, moved frequently, witnessed parental alcoholism, fights between their parents, and other forms of family trauma. They experienced poverty, prejudice, and racism. They were the victims of neglect, abuse, and abandonment. They suffered from the loss of a sibling or of one or both parents, mental illness in one or both parents, and suicide in the family. Only 58 out of the 400 individuals studied by Goertzel and colleague had a normal, loving, and supportive family, which led the authors to conclude that a happy home environment does not predispose one to become creative. Limitations of studies based on biographical and autobiographical material are well documented, and the individuals reviewed by Goertzel et al. were eminent, which does not necessarily imply that they were creative.

However, these studies are not alone in their claim of a relationship between creative individuals and traumatic home environments. For example, Robert Albert found that a higher than average percentage of creative individuals experienced parental loss early in life (30% of eminent people studied suffered the loss of one parent, as compared to 8% in the general population).

Creative children are likely to experience more tribulations than their equally bright but less creative peers. It has even been intimated that a certain tension between parents and children furthers independent thinking, whereas a harmonious relationship tends to promote a more conventional thinking style. Children's response to stress may both be influenced by and play a role in determining the development of their creative potential.

A distressing family environment does not automatically result in creative outputs. Indeed, William Therivel affirmed that different types of childhood afflictions may result in different outcomes. For example, trying relationships with parents, early parental illness, parental absence, or parental loss are tragic and painful for a child. However, these forms of adversity will not lead to feelings of hostility toward parents and other adults. Abuse, on the other hand, will often elicit strong opposition to all forms of authority. Individuals who underwent this type of trauma might be creative in their lifestyle, but will not be engaged in significant creative pursuits.

Children who experience a strained relationship with their parents may try to minimize contact and turn to intellectual and creative activities for solace. They are likely to feel in control within their domain of predilection. This feeling may help partially remedy the lack of control that they experience in their everyday life. They also involve themselves in creative pursuits to fulfill their emotional needs. In addition, being ignored or rejected by parents seems to lead to the development of a unique identity, distinct from those of the parents, which appears to be a critical element of the creative personality.

Furthermore, difficult home environments are likely to interfere with the normal process of socialization. Children sometimes have parents who are unable or unwilling to guide them through social mores, appropriate behavior, and rules. They may also fail to enroll them in traditional schools. These children then acquire limited knowledge of conventions, which Therivel referred to as 'scripts.' They are also prone to reject these scripts, and as a result, become autonomous, divergent, and independent thinkers. Further, absence of parents automatically results in children being unable to create bonds and identify with the absentees. Lacking a role model, these children are likely to have more unconventional and unusual lives. More immediately, a problematic home life leads children to feel different.

Solitude

Many creative achievers and other gifted individuals were often rejected by others as children because they were deemed different. Rejection made them hypersensitive and tense. As a result, and because of their particular home situations, they spent a great deal of time alone as children. Time alone has been deemed critical to the development of the creative individual, and children used the time to read, learn, practice, and acquire new areas of knowledge. In addition, many creative and imaginative children who spend quite a bit of time alone develop a rich fantasy life. A vivid imagination is believed to stimulate the use of imagery and visualization, which can be used later to problem solve. Furthermore, fantasy is an effective strategy to cope with emotional and psychological trauma and pain. Within their imaginary worlds, children are able to rectify the ills of their lives and play out scenarios in which they emerge victorious.

Regardless of the cause of their isolation, creative children come to develop a taste for solitude, and eventually even seek it out. This ability to be alone and enjoy it appears to be an important skill to possess, particularly in adolescence, when the lure of the crowd is particularly powerful. More generally, early adversity is likely to prompt children to develop a repertoire of responses and personality characteristics that are not only conducive to creative achievement but also prepare the individual for the risk taking inherent to the creative professions. Furthermore, these responses acquired in childhood may be very useful when facing the uncertainties, difficulties, and marginality often characteristic of the lives of highly creative people.

Outcomes

Children react in a multitude of ways to situations of dysfunction. As adults, they may try to capture the fear and panic and anxiety of their childhoods in their creative works. For example, early hardship could be a recurring theme in the individual's life, a haunting theme that the individual may revisit and attempt to rework and rewrite in a more satisfactory fashion. In addition, individuals may try to compensate for rejection or abandonment in childhood through a high desire to achieve. Indeed, inborn talent in addition to the motivation to surmount adversity might help account for the development of creative individuals who lack family support.

Further, Howard Gardner posited that creative individuals favor a certain level of anxiety and stress because it was a prevalent emotional state in their childhoods. They seem to crave some discomfort in their lives and feel anxious when tension is absent in the situation or within themselves. They then tend to generate stress in their professional and personal lives by engaging in different kinds of behaviors. However, it seems that there also exist creative individuals who did not develop creatively through tension and trauma, but through more conventional routes.

As discussed previously, creative individuals tend to grow up facing adversity. However, there is a certain level of disagreement regarding the topic. Indeed, there are studies proposing that creative achievers also come from stable, happy, and supportive families. Contrary to Goertzel and colleague's findings, these scholars stated that artists, musicians, scientists, and athletes also grow up in healthy atmospheres. Indeed, they claim that the most creative and productive of achievers come from such encouraging contexts. They also argue that outside the art world, there is little evidence of family malfunction. For example, scientists, inventors, and mathematicians are believed to come from stable families. Inventors in particular seem the less likely to have had stressful childhood homes.

These findings are reflected in Rogers' Theory of Creative Environment, which states that for constructive creativity to develop, the presence of two conditions is required: psychological safety and psychological freedom. Psychological safety is fostered when an individual is regarded by his/her environment as having unconditional worth, when the environment is nonjudgmental, and when the individual feels understood. The former is achieved when the individual is allowed to express him or her self freely. Rogers' theory was later empirically supported. According to this theory, the most central element to the development of creativity is for a child to receive unconditional positive regard from his/her family.

There are researchers who support neither the tense and tough home environment hypothesis nor the nice and loving home environment hypothesis and advance instead that happy families contribute to everyday creativity, where people live productive and helpful lives, whereas a certain amount of stress characterizes the background of eminent creators.

Stress and support are not irreconcilable, and it is possible to conceive of a family filled with stress and tension, and yet, giving the child unconditional positive regard and catering to his/her needs, interests, and achievements.

Reconciliation

Stress alone does not necessarily promote creativity, but stress in addition to support is a more likely formula. For example, Cervantes, Picasso, Freud, Einstein, Goethe, Beethoven, Dickens, and Marx are believed to come from such a background. Moreover, although families of creative individuals tend to be tense and stressful, they may also be structured in a way that buffers stress. For instance, parental neglect may be counterbalanced by attentive siblings, relatives, or friends. A child with an abusive parent may receive attention and love from the other parent. Even in situations of poverty, parents of creative achievers frequently attempt to shelter their children from adversity and emphasize the importance of books and education.

Thus, parents interpret the situations for their children, and these interpretations affect how the child will react to the events. In particular, this parental intervention might trigger a certain level of resilience in the children. Their creative talents and the enriched, child-centered home environment may also contribute to these children's ability to navigate difficult times. Resilience does not mean immunity from stress, but rather the capacity to cope well and be able to function even in the midst of adversity.

Further, resilient children and creative children share many characteristics. Indeed, both are likely to be curious, intelligent, and fast learners. They are able to concentrate and problem solve. Both also seem to have good self-esteem, and be independent. In terms of family background, and again, consistently with creative children's profiles, resilient children are close to their parents. These parents are likely to be authoritative, and are loving, communicative, and supportive. They hold high standards, and supervise their children closely.

It is important to note, however, that most childhoods marked by adversity lead to negative outcomes. For instance, poverty can prevent parents from having enough time for their children, and lack of parental involvement and support have been associated with low self-esteem and behavioral problems. Mihály Csikszentmihályi stated that when one has to fight to guarantee basic survival, there is no time and resources left for anything else. In addition, not all creative achievers are resilient since a higher than average percentage of creative writers and other creators suffer from a mood disorder.

Complex Families

Gary Gute, Deanne Gute, Jeanne Nakamura, and Csikszentmihályi applied a conceptual framework called the Complex Families Framework to the family's contribution to creativity. This is a fitting framework to include here because it pulls together many of the ideas and themes visited in this entry.

According to this framework, complex systems seek to both differentiate and integrate in a continual, organic process. Family members differentiate by pursuing their own goals and developing a distinct identity. They value independence and involve themselves in activities that require increasingly more advanced skills. These activities also provide appropriate levels of difficulty. Differentiation includes parents facilitating the discovery of new interests and challenges for their children. Parents also model perseverance, self-discipline, and hard work. Thus, creative children observe their parents fully immersed in hard intellectual work and witness the satisfaction derived from it.

Family members integrate by pursuing harmony and continuity through emotional support. They also weave cohesive bonds with each other by establishing common values, traditions, and goals (Deng et al., 2016). Thus, integration provides support, security, and a sense of belonging. Integration also involves parents supporting their children's interests and skills, spending time with them, establishing values and rules, and responding to failure intelligently. Another aspect of integration involves the heterogeneous backgrounds, geographical or ethnic origins, ideological positions, or personalities of family members. Indeed, Goertzel, and Goertzel highlighted that first- and second-generation immigrants were well represented among the eminent individuals they studied. Likewise, first- and second-generation immigrants distinguish themselves on creativity tests. These findings are consistent with other empirical results suggesting that bi- and multilingualism, bi- and multiculturalism, as well as immersion in a milieu that tends to question or present alternatives to accepted norms and values stimulates creativity. This diversity within the family allows children to experience varied approaches to the world, as well as varied ways of thinking and doing.

Establishing a good balance between differentiation and integration seems imperative. An over-focus on differentiation would favor the development of eminent (and noncreative) levels of talent. An overemphasis on integration would result in stability and competence but neither in talent nor in creativity. Expectations and boundaries need also to be in place to create a healthy structure.

Conclusions

The contribution of the family to creativity begins early in life and continues as creativity progressively evolves during the lifespan. The family may provide a climate conducive to the child's creative talent development. However, being child-centered does not exclude the presence of stress, and stress might elicit specific kinds of reactions and engender particular personality characteristics that are favorable to creativity but also to the creator's tumultuous lifestyle and career. Although trauma plays an important role in the evolution of creativity, it seems that normal, happy families can fuel creativity as well. It is possible that everyday creativity originates from such a milieu, whereas eminent creativity appears to necessitate some level of tension. It also seems likely that creative achievers come from hectic backgrounds that are also loving and supportive. Parents might filter external stressors and interpret the world for their children, and thus render the stress manageable.

Hence, high levels of creative achievement may rely on the desire to succeed, particular characteristics emerging from childhood trauma, as well as the need to fulfill emotional and psychological needs. It may be that a less dramatic balance of support and stress results in other levels of creativity. Creative achievers who lack family support may have to rely on their inborn talent as well as their motivation to overcome adversity in order to succeed.

Thus, elements conducive to the development of creativity in young people include both challenge and support. Young people are then likely to value and take pleasure in hard work and productivity, enjoy what they do, and thus derive self-esteem and feelings of competence from it. It also seems that one of the central aspects of creative people's lives is complexity. Complex families are able to establish a balance between supporting their children and establishing boundaries and rules; spending time with their children and yet resisting controlling them; having high expectations and yet recognizing that experimentation and failure are normal. It seems that families who find the right balance between integration and differentiation offer an environment that is optimally conducive to the development of lifespan creativity. Thus, the family context of creative children is likely to strongly influence whether the individual ultimately lives up to his/her potential or not.

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Introduction

Film has been called the “seventh art,” after painting, sculpture, architecture, music, dance, and poetry. Yet the comparison is somewhat misleading given the great antiquity of the other six forms of artistic creativity. Where the six were already well established by the time of ancient Greeks, film did not emerge until the early 20th century. Even then, film was not immediately recognized as an art form. The medium had originally evolved from the application of photography to the study of motion. Later these “moving pictures” became a form of popular entertainment, a transition perhaps best symbolized by the advent of Nickelodeon theaters.

But, as films became longer and more complex, the medium’s potential for artistic creativity began to become realized at the hands of several classic filmmakers. By the 1920s, certain feature-length narrative films began to be viewed as works of art. By the end of the decade, the Hollywood film industry formed the Academy of Motion Picture Arts and Sciences, which soon began awarding Oscars for major cinematic achievements. Not long after the first film festivals began to appear, starting with Venice in 1938 and the famed Cannes Film Festival launching in 1946. During these years film criticism appeared as an independent branch of journalism, and eventually the form received academic endorsement with the appearance of film studies programs at major universities.

By the latter half of the 20th century there seemed to be no doubt that film could claim its proper place as the seventh art. In the United States, for example, the National Endowment of the Arts created the American Film Institute dedicated to celebrating the art of film. Soon AFI was publishing ranked-order lists of the all-time masterworks in the form. Another development that took place in this period was the materialization of “Auteur theory.” This doctrine began in the mid-1950s with the critics of the French New Wave, and it was further developed by film critics and scholars in the US. The basic idea was that film provides an artistic medium in which filmmakers – most often the directors – should express their personal creative vision. This theory gave the seventh art a more even status with the earlier six. Just as painting has Rembrandt, sculpture Michelangelo, architecture Le Corbusier, music Beethoven, dance Balanchine, and poetry Shakespeare, so does film have such creative geniuses as Pedro Almodóvar, Ingmar Bergman, Luis Buñuel, Sergei Eisenstein, Federico Fellini, Werner Herzog, Alfred Hitchcock, Akira Kurosawa, Spike Lee, Roman Polanski, Jean Renoir, and Yimou Zhang.

Although film is now recognized as a legitimate medium for artistic creativity, it has received much less research attention in comparison to the other arts. It is likely that one reason for this neglect has to do with its recent entry into the list of artistic media. Yet another reason may be no less crucial: Film is inherently a collaborative product. Even the core crew and cast consist of dozen of individual talents who must collaborate in the creation of the final product. As an instance of group creativity, it does not lend itself well to the most common research methods, such as laboratory experiments. Indeed, laboratory investigations of film tend to focus on empirical questions that are only tangentially related to cinematic creativity. For instance, a large number of experiments have been devoted to assessing how music can affect the processing of visual information. Despite the importance of the findings from the perspective of cognitive psychology, the connection with cinematic creativity is more remote. As a case in point, empirical

[☆] *Change History:* June 2019. Dean Simonton updated the text throughout the article.

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research by [Simonton \(2011\)](#) shows that the quality of a film depends very little on the quality of the film score. It is possible that the more the music draws attention to itself the more it detracts from the film's overall impact.

The last point raises a critical question: How does one assess cinematic impact? On what basis can one film be called a masterpiece, another mediocre, and yet another a turkey or bomb? This question can be answered more than one way – a point that must be demonstrated next.

Impact Criteria

Scientists who study cinematic impact have a multitude of choices for the criterion variable. For example, investigators will sometimes use consumer surveys or, more recently, popular assessments posted on the Web (e.g., Internet Movie Database “user ratings”). Nonetheless, the vast majority of investigators tend to use one or more of the following three sets of criteria: critical evaluations, financial performance, and movie awards.

Critical Evaluations

Professional critics provide evaluations of the hundreds of films released each year. These assessments are often expressed in quantitative form, most often stars. Thus, one film might get 5 stars, another 2 ½ stars, and yet another just 1 star. This practice permits the direct comparison of the degree of critical consensus. Research has shown that the agreement is extremely high even if not perfect ([Simonton, 2011](#)). For the most part, the best films tend to receive consistently high marks whereas the worst films earn consistently low marks. As a consequence, composite measures using the ratings from multiple critics will exhibit reliabilities comparable to standard psychometric instruments. In addition, the critical evaluations display considerable stability across time. This stability becomes apparent when the assessments published during the film's theatrical release are compared with the assessments published after the film becomes available for rent or sale in video or DVD format. Despite a temporal separation of two or more years, this “test-retest” reliability also compares favorably with that seen in the best psychometric measures. Composite critic evaluations have another feature: The scores tend to be normally distributed, masterworks and turkeys being much rarer than mediocre films. Finally, because critic evaluations constitute expert judgments, such assessments have strong face validity as well. The composite measures can be considered a version of the consensual assessment technique [see Consensual Assessment].

To be sure, critic evaluations have been disparaged as representing elitist evaluations. Film critics seem to prefer foreign-language, small-budget art-house films over the mainstream Hollywood wide-distribution blockbusters. However, this complaint is not completely justified by the research. Critical evaluations are positively correlated with consumer judgments. The main difference between critics and consumers is the quantity of films watched. Those consumers who are avid moviegoers are more likely to concur with critical opinion. Still, researchers concerned about critical elitism can turn to the next impact criterion instead.

Financial Performance

Although film is recognized as art, it must also be acknowledged that the film industry is big business ([De Vany, 2004](#)). Like any business, the goal is to make a profit, and that end is only achieved if the film attracts large crowds of consumers to the movie theaters. Admittedly, films can also earn money through video/DVD rentals and sales as well as television broadcasts and streaming sites. Yet even these earnings often depend heavily on previous box office success. People are more likely to buy or rent a DVD of a blockbuster than a financial flop. Accordingly, financial performance can be used as an indicator of popular acclaim, as distinguished from critical acclaim.

Financial performance can be assessed a multitude of ways. The most common measure is US domestic box office gross. Less common is world gross earnings, which is not always available. Another alternative is the first weekend gross or the first week gross. Yet it should be noted that all of these figures could be misleading without introducing some adjustment for budget (or production costs). Budget is strongly associated with advertising and promotion expenses, and the latter are highly correlated with box office returns. Profit is what is left over after these costs and expenses are subtracted. Usually a film must gross at least twice its budget to become profitable. Consequently, most films lose money in the theaters. If it were not for the minority of blockbusters that reap huge profits, there would be no film industry, at least not without substantial government subsidies.

Interestingly, although critical evaluations are normally distributed, financial performance has a highly skewed distribution with a long upper tail. So poor are the financial expectations for films at the bottom end of the distribution that a significant percentage of the films made each year go directly into video/DVD or streaming, bypassing the theaters.

Movie Awards

The third way of assessing cinematic impact is to use awards [see Awards]. Various organizations offer numerous nominations and awards each year. Besides honors for best picture, these can include recognition for direction, writing, acting – male/female and lead/supporting – cinematography, art direction, costume design, makeup, score, song, special visual effects, sound effects editing, and sound mixing. Some of these awards are bestowed by professional or guild organizations, such as the Academy of Motion Picture Arts and Sciences or the Screen Actors Guild, whereas others are distributed by critics associations (e.g., the New York

Film Critics Circle). The Hollywood Foreign Press Association, a society of journalists, grants the famed Golden Globes each year. Despite the diversity of award organizations, they tend to display a consensus regarding the recipients. The agreement is almost as strong as that seen for critical acclaim, albeit the consensus is greatest for the most salient honors, such as best picture, direction, and acting. Furthermore, the consensus does not extend to awards earned at film festivals. The latter tend to be more capricious regarding the competition.

One major advantage of movie awards is that they provide a more finely differentiated profile of cinematic impact. Critics assign a single overall rating just as the financial records provide a single figure. Although best picture honors are similarly global, the remaining honors are more specific. However, these more specialized awards cluster into four groups: (a) dramatic (direction, writing, acting, and editing), (b) visual (cinematography, art direction, costume design, and makeup), (c) technical (special visual effects, sound effects editing, and sound mixing), and (d) musical (score and song). Some films might receive the major dramatic awards without receiving recognition in the other clusters. It is significant that the dramatic awards correlate highest with best picture honors (Simonton, 2011).

Movie awards do have some drawbacks as impact criteria. First, like financial performance, counts of awards and nominations are highly skewed. Only a minority of films are even nominated for any award, and a smaller proportion of these actually receive one. Second, the awards and nominations are often influenced by factors that are extraneous to actual cinematic merit. For instance, the larger the number of prior Oscar nods a director receives the higher the probability that he or she will win the award (Pardoe and Simonton, 2008). Third, certain genres are favored over others. Dramas are far more likely to win a best picture Oscar than are comedies. Horror and science fiction are even more disfavored than comedies.

Criteria Correlations

If these three sets of impact all highly intercorrelated, then it would not matter which one was actually selected for study. One might serve as a proxy for all. Better yet, the three sets could be combined into a single composite measure of cinema greatness. Unfortunately, the empirical results yield a more complex picture (Simonton, 2011).

To start with, the correlations between critical evaluations and financial performance are only weakly positive. Some researchers even find zero or negative correlations. Many of the inconsistencies can be attributed to the specific criterion in each category. For instance, although critic evaluations will often correlate negatively with first-weekend gross, they will more often correlate positively with total gross earnings. The early financial success of a film is often heavily influenced by promotion and advertising, whereas its ultimate success is contingent on aesthetic quality, which the critics do a good job assessing. The connection between critical acclaim and box office success is moderated by other factors, too, such as the presence of stars. Moviegoers will often buy tickets to see a star-studded film even if it is panned by the critics.

Financial performance also has an ambivalent relation with movie awards. One complication ensues from the timing of a film's release. If a film comes out toward the end of the calendrical year, then its receiving special recognition can enhance its box office success. But if a film is released early in the year, it may no longer be in the theaters by the time the award ceremonies begin. In that case, the question becomes whether its financial performance might earn it some honors. Another nicety concerns the distinction between nomination and actual award. These are seldom announced at the same time, and this temporal lapse can affect the association. As an example, consumers may go see the movies that have received Oscar nods for best picture, but not go back to see again the film that actually won. In that situation, the nominations but not the awards influenced financial performance. One final complication is that only high-profile recognition bears any relation with financial performance. Few consumers go see a film to enjoy its sound mixing.

In contrast, the correlations between critical evaluations and movie awards are consistently and unambiguously positive. It is rare for a critically acclaimed film not to receive such recognition. Indeed, the correlation would probably be much stronger if it were not for the rather divergent distributions for the two sets of variables. The fine distinctions that critics make at the lower end of the distribution have no repercussions because nominations and awards are almost never allotted to the films at the bottom. Nevertheless, it is essential to point out that not all movie honors are in accord with critical commendation. In particular, critical evaluations correlate most strongly with the awards in the dramatic categories, with direction and writing having the greatest weight. Critics seem to prefer most a great script realized by great direction; the actors and editor merely helping to achieve that realization (Simonton, 2011).

It would seem that of the three sets of criteria, box office is the "odd person out." Critical evaluations and movie awards agree more with each other than either agree with box office indicators. To appreciate the basis for this split, we need to look at the factors that predict each set of impact criteria.

Criteria Predictors

The three sets of impact criteria – critical evaluations, financial performance, and movie awards – can be predicted using a large inventory of variables. Because these predictors have contrasting relations with the criteria, the latter are clearly not assessing the same type of cinematic impact. In fact, it should become evident that there are really two general kinds of film, one concentrating

on artistic creativity and the other on the entertainment business. This discrepancy shows up in the following sets of predictors: budget, screenplay, personnel, and distribution and exhibition.

Budget

Aficionados, consumers, critics, and professionals routinely distinguish films according to their production costs. Big-budget films seem to be most favored by the Hollywood studios while small-budget films are more often produced by independents. The costs of making a film have decided repercussions for all three sets of criteria (Simonton, 2011). In the case of financial performance, the size of the budget correlates strongly with first-weekend earnings and with total domestic gross. In other words, it takes money to make money. As noted earlier, part of this relation is mediated by expenditures on promotion and advertising. The more producers spend the more they are willing to pay for selling the film. Big budgets mean big business for everyone in the industry. Yet, as also mentioned earlier, all of these expenditures on production and promotion do not necessarily result in big profits. On the average, every additional dollar spent on the film brings only about half that amount in return.

By comparison, critics seem disinclined toward big-budget products. Production costs have a negative association with the reviews that a film receives during its theatrical run as well as the reviews received after its video or DVD release. The relation with movie awards is more equivocal. Although costs are positively associated with awards in the visual, technical, and music categories, production costs have no correlation with awards in the categories of best picture, direction, writing, and acting. It seems that money can buy excellence in the secondary aspects of the film experience, but cannot necessarily do so in the primary aspects. Many of the greatest films were actually medium- or even low-budget products. However, because the correlation is zero, there will be instances of big-budget films that obtain awards in the dramatic categories.

Screenplay

From what has been indicated so far, film as art focuses on drama. And the key component of drama is the script or screenplay. The best directors and actors cannot salvage a bad story with implausible characters. Naturally, these scripts vary tremendously not just quality but also in content. So far, research has identified the following seven sets of attributes as being particularly important in separating out the three sets of criteria (Simonton, 2011).

1. *Sequels* are successors to an earlier film, such as the last two parts of the *Godfather* trilogy. Sequels do well in terms of financial performance. At least they gross more, especially in the first weekend. They are not necessarily more profitable, however, because sequels often have higher production costs. There is pressure on the producer to outdo what came before. It is interesting to report that sequels are more prone to receive awards in the technical categories because this implies that the extra money is being spent on bigger and better explosions and car chases. Yet this success has a price because sequels are less likely to win honors for best picture and for the dramatic categories of cinematic achievement. In line with this negative result, sequels receive lower praise from film critics.
2. *Remakes* are similar to sequels in being dependent on an earlier film, only the dependence is even greater. Remakes have very similar consequences as well. On the one hand, they tend to gross more, especially in the first weekend. On the other hand, remakes are less likely to win awards in the major dramatic categories – direction, writing, and acting – and they are more likely to be panned by the critics. Remakes, like sequels, are show business, not artistic expression.
3. *Adaptations* are like sequels and remakes in bearing some link with a previous creative product. Yet the predecessor now comes from a different medium, especially plays and novels. In terms of box office, adaptations from novels are neither better nor worse than average while adaptations from plays have poorer financial performance. As might be expected, adaptations have higher odds of winning awards in the principle categories of cinematic achievement. If the adaptation comes from a classic literary work, the resulting film is also prone to receive recognition for art production, costume design, and makeup. Such visual honors represent the typical “costumer” based on a novel by Charles Dickens or Jane Austin. Given the critical preference for fine art, it should come as no surprise that adaptations are more apt to earn critical acclaim.
4. *True stories* purport to represent real events, albeit with varying degrees of factual accuracy (e.g., “based on a true story”). A special case of true stories is the *biopic* that claims to narrate the life of a real person. Because the scripts of true stories and biopics are often adaptations from nonfiction, they have somewhat similar correlates. They tend to do less well at the box office but score higher in critical reviews, plus earn more awards for best picture and the dramatic and visual clusters.
5. *Genre* is an extremely complex attribute simply because there are so many different varieties that can be combined in almost unlimited ways – like the horror sci-fi comedy. Even so, one genre dominates film scripts, namely, drama. Well over half of mainstream films are dramas of one kind or another. Dramas make for good art, too, for they tend to receive higher critical praise and they have a higher likelihood of winning awards in the principal categories. On the down side, they are less likely to earn recognition in the technical categories, and they earn less at the box office. Film dramas are too serious to make business sense.
6. *MPAA ratings* are determined by the Motion Picture Association of America. They are designed to ensure that films are exhibited before appropriate audiences. For current purposes, the most relevant ratings are R and PG-13. The former indicates “Restricted, children under 17 would not be admitted without an accompanying parent or adult guardian” and the latter “Parental Guidance advised, parents strongly cautioned because some material may be inappropriate for children under 13.” Films rated PG-13 do

the best in the box office, those rated R the worst. Yet R-rated films earn higher critical acclaim and receive more recognition in the dramatic cluster of movie awards – but less recognition in the remaining three clusters. Needless to say, many R-rated products are dramas.

7. *Mature content* indicates serious material unsuited for children or unwelcome by some adults. The most conspicuous types of mature content are highly graphic sex and violence. Although this attribute is partly captured by the MPAA ratings, the latter are too broad to make appropriate distinctions. For instance, an R-rated film might contain no sex or violence, but just profanity, while a PG-13 film might contain some nudity and killing. Consequently, it is of interest to learn the impact of mature content apart from the MPAA ratings. Here the contrast between art and entertainment is quite conspicuous. On the artistic side, both critical acclaim and movie awards in the major categories are positively associated with tense family scenes, controversial topics, and, oddly, smoking – the latter perhaps a sign of a “serious” film product. On the entertainment side, box office gross is positively associated with scary or tense music, frightening or tense scenes, but negatively associated with sex and nudity, profanity, and alcohol or drugs. These financial measures hold for US domestic, UK, and worldwide box office.

Although the preceding variables all have contrasting associations with the three sets of impact criteria, one attribute has been found to be positively correlated with all three, namely runtime. Evidently, the longer the film the more opportunities it has to display the full range of cinematic effects. It then earns more money, gets better reviews, and wins more awards in all categories. Yet film length is also a rather crude indicator of screenplay characteristics.

Personnel

Shakespeare’s plays can be read with pleasure and profit without seeing them on the stage, but screenplays rarely enjoy that expressive autonomy. Instead, the script must be translated to the screen, a translation that demands the direct contributions of cast and crew. The impact of the final cinematic product will also depend on those contributions. Let us start with the cast and then turn to the crew.

The cast consists of the talents in front of the camera, especially those actors in leading roles. The bulk of the empirical studies narrowed their analyses to the impact of the “movie stars” occupying those roles (Simonton, 2011). With respect to critical evaluations, there is some reason to believe that acclaimed films are more likely to feature performances by male and female actors who had previously won Oscars. Moreover, performers who have accumulated previous acting nods are more likely to deliver Oscar-winning performances. Regarding financial criteria, the impact of stars is inconsistent and unstable. Although films with star names on the marquee are likely to gross more, such films are often not cost effective. Because stars earn so much more money, the increase in budget frequently cancels out any gains in box office. One last point is of interest: The impact of male stars exceeds that of female stars. At least this holds for both financial performance and best picture awards.

Research on members of the crew has so far confined attention to producers, directors, writers, and composers (Simonton, 2011):

1. Producers have only been studied with respect to financial performance, but with paradoxical results. On the one hand, producers with prior box office success are more likely to continue that success. On the other hand, the greater the number of prior films produced the lower the odds of an exceptional box office for a current film.
2. A similar paradox happens to directors: prior box office performance predicts positive box office for current films but prior credits predicts negative box office for current films. As a result, the net effect of “star” directors is zero. But when we turn to movie awards, these do tend to be predicted by prior movie awards: Outstanding directors continue to win. Yet with respect to critical acclaim, directors display an inverted-U function of age similar to what is found in other forms of creativity. The films for which a director receives the highest critical praise tend to appear mid-career.
3. While award-winning writers are prone to write additional award-winning films, the findings are less simple for that subset of writers who also direct their own scripts. On the one side, films made by writer-directors tend to be favored by the critics, and on the other side, films written and directed by the same creator tend to do less well than average at the box office. Because Auteurs are often writer-directors, these findings suggest that Auteur theory applies more to film as art than to film as entertainment.
4. Composers appear largely irrelevant to a film’s financial performance. At least box office is unrelated to awards received for best score or best song. In comparison, award-winning compositions are positively associated with best picture honors. The critics are less enamored of film music, especially in the case of songs. One curious finding is that the aesthetic impact of a film composer’s work is largely decoupled from the overall cinematic impact of the film. Sometimes a composer’s best work is found in a lesser film.

All in all, the cast and crew make rather divergent contributions to a film’s cinematic impact. The magnitude and direction of their effects depend on the specific criterion.

Distribution and Exhibition

Until very recently, with the advent of Netflix streaming, a film could not even receive critical evaluations, earn a box office gross, or win movie awards unless it has some theatrical release. This leads to two final variables that are differentially associated with the impact criteria (Simonton, 2011).

First variable is the season of release. Regarding financial performance, it is patent that the big blockbusters are released in the summer months, when children and adolescents are on vacation. In contrast, critically acclaimed films as well as those with the highest odds of winning movie awards are most likely to be released toward the end of the year, during the so-called Christmas season. Interestingly, the worst movies by any standard are usually released early in the year – a dumping off period for films that do not go directly to video.

The second factor is the number of screens on which the film is exhibited opening weekend. Wide-release films not only do better on the first weekend, but also tend to gross more in the end. Yet such films are more likely to receive negative reviews from the critics, who lean toward films that do the art-house circuit, a few screens at a time. Although the number of screens is unrelated to movie awards for best picture and in the dramatic and visual clusters, wide release is positively associated with honors in the technical and music clusters. This pattern suggests that wide release is reserved for entertainment rather than for art.

Discussion

An overall pattern is apparent in the above review: Films can be separated into those devoted to creative art and those dedicated to the entertainment business. The former are inclined to receive critical acclaim and movie awards in the primary categories, whereas the latter are more disposed to do a handsome box office and to earn awards in the secondary categories, such as special visual effects and sound effects editing. The two types of film can also be distinguished with respect to production costs (small vs. big), screenplay (e.g., sequels vs. adaptations, R vs. PG-13 MPAA rating), personnel (e.g., writer-directors), and distribution/exhibition (e.g., summer vs. winter release). Although there are a few variables that cut across the two cinematic types – most notably long runtimes contributed to both art and entertainment – these exceptions are rare. Often the predictors will have opposite signs for the two types.

To consolidate these findings further, it is necessary to discuss some methodological and substantive issues. This discussion can help improve the quality of future research on cinematic creativity.

Methodological Issues

The empirical findings summarized earlier represent the most common results. Nevertheless, it is important to admit that the literature is not always consistent, and sometimes outright contradictory. After subjecting these discrepancies to scrutiny, it becomes clear that they often emerge out of methodological differences. The following four contrasts are the most telling:

1. *Sampling* – Research varies greatly in the criteria used to obtain a sample of films. In the first place, studies might differ in the historical period covered, some taking films from the Golden Age of Hollywood while other studies taking only very recent films. This difference has been shown to affect the outcomes. Even when the periods spanned by the sample are the same, researchers will often employ inconsistent sampling criteria. To illustrate, the films might be defined by (a) a random sample from all released films, (b) films that received at least one nomination for some movie award, (c) those that earned a certain minimum amount at the box office, (d) those that featured at least one movie star, or (e) films that received a certain minimum number of critical reviews. Rendering matters worse, investigators do not always agree on whether to include documentaries, animations, foreign-language films, or even shorts. It is unreasonable to expect the same results to come from samples so different.
2. *Variables* – Because researchers in this area hail from a great diversity of disciplines – among them psychology, sociology, economics, management, marketing, communications, journalism, broadcasting, and statistics – they often approach the subject from rather divergent theoretical perspectives. Consequently, each study will contain a different mix of variables. For instance, marketing researchers are more likely to want to put expenditures on promotion and advertising into their prediction equations. Yet the omission of these expenditures by other investigators can alter the conclusions. For example, much of the relation between budget and gross earnings vanishes once expenses on promotion and advertising are controlled (or “held constant”). Hence the latter provides the most proximate predictor of financial success.
3. *Measurement* – Even if two studies used identical sampling criteria and included the same variables, they might obtain contrasting results because of disagreements on how to best define the key variables. Undoubtedly, the most irksome illustration comes from the concept of the “movie star.” Stars have been defined in terms of (a) best-acting awards, (b) consumer surveys, (c) box office performance, (d) total film credits, (e) investigator subjective assessments, and (f) industry-based identifications. A star by one definition is usually not a star by another definition.
4. *Analysis* – It is still possible for two investigations to concur on sampling, variables, and measurement, but obtain different findings because of divergence in how their respective data sets are analyzed. One investigator might just look at the basic correlation coefficients while another conducts a multiple regression or constructs a structural equation model. Even a single method like multiple regression can get distinguishable results if the analysis is carried out differently (e.g., simultaneous vs. stepwise). Finally, researchers will often differ in how they handle highly skewed distributions. Such divergence is especially crucial with measures of financial performance.

Until some consensus is reached on sampling, variables, measurement, and analysis, it is too optimistic to presume that researchers will come up with identical conclusions.

Substantive Issues

Assuming that the foregoing methodological issues can be resolved, it is hoped that researchers can address a wider range of substantive issues. These can be put into two broad categories.

First, future research must greatly augment the inventory of variables that might contribute to cinematic impact by any of the three criteria. Film is one of the most complex forms of artistic creativity ever devised – perhaps the most complex ever. Although researchers often feel satisfied if they incorporate a few dozen variables into their studies, such satisfaction is quite complacent. Of special importance is a more detailed attention to the screenplay. The published studies to date deal with the most basic features of the screenplay, such as genre, MPAA rating, sequel/remake, and adaptation. Even though there have been attempts to subject screenplays (or synopses) to content analyses, these attempts are clearly exploratory. The analyses come far from capturing the rich complexities of plot, character, and other dramatic components.

Second, further inquiries should also shift the unit of analysis from the film to the filmmakers – the cast and crew engaged in creating the film product. Even if film is a collaborative product, it remains the case that collaborations require collaborators. These collaborators range from creative talents to technical experts, but they all have a responsibility for the final film. There has been some empirical attention devoted to directors, writers, actors, cinematographers, and composers, but these inquiries are rather sporadic and scattered in approach. At present, the literature lacks findings that must be considered essential. As an example, although we know how the personality of artists differs from the personality of scientists, and even how scientists practicing in different disciplines vary in their dispositional makeup, we know nothing about the distinctive personality profiles of producers, directors, writers, actors, and composers – even less the rest of the core crew.

In time, we may come to comprehend cinematic creativity in all of its manifestations. Someway, such scientific knowledge might even enable producers to improve their product.

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Relevant Websites

- Academy of Motion Picture Arts and Sciences (<http://www.oscars.org/>)
 American Film Institute (<http://www.afi.com/>)
 Hollywood Foreign Press Association (<http://www.goldenglobes.org/>)
 Internet Movie Database (<http://www.imdb.com/>)
 Metacritic (<http://www.metacritic.com/>)

Flexibility

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Glossary

Adaptive Flexibility Abandoning conventional problem solving methods that have become unworkable and thinking of original solutions

Androgyny Persons who have higher than average male and female elements in their personalities

Attitude A lasting tendency or acquired predisposition to evaluate a person, event or situation in a certain way and acting accordingly

Cognition Processes of knowing, including attending, remembering, and reasoning along with conceptualization, judgment, and information processing

Divergent thinking An aspect of creativity characterized by an ability to produce unusual, but appropriate, responses to standard questions

Functional fixity The belief that objects have only one purpose

Spontaneous flexibility Producing a diversity of ideas in a relatively unrestricted situation

Flexibility has a relationship with the act of creativity in several ways. It can be manifested in cognition, which facilitates creative problem solving. Individuals can be flexible in their personalities and attitudes as well, and attitudinal flexibility may, in turn, lead to tolerance and adaptability.

Flexibility as a kind of adaptability reflects a capacity for change. People with this capacity demonstrate a change in the meaning, interpretation, or use of information; a change in the understanding of a task; a change of strategy in doing the task or a change in the direction of thinking, which may mean a new interpretation of the goal. Flexibility as a personality trait allows one to see the whole of the situation. It allows an individual to see all the components of a problem and not just one of the parts. It enables discernment of the parameters and boundaries of problems, and it often enables changing the problem itself. This is because the flexible person is capable of redefining the problem and adapting to the demands of a changing world.

Flexibility in Divergent Thinking

The relationship between cognitive processes and creativity is well-established. Many authors have detailed how cognitive processes play roles in the act of creativity. In all of these approaches, flexibility is underlined and presented as a substantial condition for creativity and thus creative people are flexible (Guilford, 1968; Runco, 1991).

Flexibility is a concept that hinges on the relationship between creativity and adaptability. Flexibility enables people to interpret the world from different perspectives and adapt to change, which may contribute to the ability to make associations and a greater openness. Flexible individuals usually have alternatives and diverse solutions when solving problems. Thus, they more likely reach solutions and are less likely to have distress and frustration. Inflexible individuals, on the other hand, usually follow routines and are stuck with a solution used earlier.

Flexibility is an important aspect of the cognitive process. It has been evidenced that divergent thinking is a very useful estimate of creative thinking potential. Tests derived from the well-known divergent thinking model assess creative thinking potential by measuring four dimensions: originality, fluency, flexibility, and elaboration. Thus, creative individuals are expected to demonstrate fluency, greater originality, more flexibility and elaboration. Fluency is about the generation of a quantity of ideas. It is measured by presenting very simple tasks (e.g., list all the things you can think of that are hot and solid), and the quantity of output gives the

fluency scores. Originality on divergent thinking tests has to do with looking beyond obvious solutions, novelty, and generating novel ideas and responses. The more the statistical infrequency of responses, the more the originality. It is measured by the production of unusual, remote, far-fetched, clever and breakthrough solutions. Elaboration is the ability to expand on an idea and enlarge it with details. Unlike fluency, it refers to the details within each idea. Finally, flexibility is manifested when the responses or solutions move from one ideational category or theme to another. The more the category of ideas or ideological shift in thinking, the more the flexibility.

The divergent thinking model has been criticized because of the moderate predictive validity of divergent thinking tests and the ambiguous associations with creativity occurring in the natural environment. It is obvious that divergent thinking and creativity are separate constructs; however, divergent thinking tests provide very useful estimates of the potential for creative thought. Recent research indicates that divergent thinking tests produce the most impressive validities when flexibility is incorporated into the assessment and prediction (Runco, 1986).

Types of Flexibility

Flexibility has two types: spontaneous flexibility and adaptive flexibility (Guilford, 1968). The former is termed spontaneous because it can appear as a natural tendency or spontaneous preference for change for intrinsic reasons. It is the ability to generate diverse solutions to a problem when there is no external pressure to be flexible (Thurston and Runco, 1999). In some divergent thinking tasks to measure spontaneous flexibility, an examinee may be asked to list as many ideas as possible regarding the use of a common object such as scissors without being given the suggestion to be flexible on tests. The score for ideational fluency is the total number of uses listed and the test can also be scored on the number of times the category of use is changed. For example, the responses of “cut hair”, cut paper, cut fabric” does not change the class of use. On the other hand, the response of “make the letter X, make a paperweight, use as a screwdriver, use as a draftsman compass,” etc., changes class with each new response. The examinee who has the tendency to change conceptual categories easily and provides more categories demonstrates much more spontaneous flexibility.

The other type of flexibility is called adaptive flexibility or redefinition. It can appear under the pressure to adopt to a challenging external environment. It is the ability to adopt new strategies to solve a problem when old methods do not work, or to redefine the problem in order to find an original solution. It occurs in relatively difficult tasks. Adaptive flexibility can be measured by designing tests to identify the ability to see ordinary things in the environment from a different perspective, and make connections between distant points (Georgsdottir and Getz, 2004). An examinee must make some kind of modification either in the interpretation of the task, in strategy or approach or in possible solutions. There should be substantially modified responses that represent a transformation to adaptive flexibility. Adaptive flexibility in response to environmental constraints can introduce creative outcomes. For example, approaching problems in new ways and shifting perspectives on a problem can facilitate creative solutions and creative insights.

Flexibility in Insight Problems

Wallas suggested that the creative process includes four stages: preparation, incubation, illumination, and verification. The third stage, illumination is also known as insight. It is best known because it appears with an a-ha experience. Schilling (2005) defined insight as making unexpected connections between disparate mental representations. Insight usually leads to one solution. When we have a problem, a solution or idea pops into our minds. It is sudden or, at least, feels that way.

In creative problem solving, insight problems are frequently used and require flexibility. Among insight problems presented by Schilling (2005), nine dots and two-string are well known. In the nine-dot problem, for example, nine dots are presented (see Fig. 1), and the examinee is asked to connect all nine dots with four straight lines without lifting pen or pencil from the paper until the dots are connected.

Most people assume that a boundary is imposed by the eight dots making up the perimeter of Fig. 1. Although no such boundary or constraint is given in the direction, people usually stay within that self-imposed perimeter while attempting to solve the problem. This indicates that they may be generating assumptions that limit their thinking. This also says something about how we structure our perceptions toward Gestalten or have an inclination to complete figures. What is most relevant here is what the experts say about flexibility –or the lack thereof. When the examinee sticks with one approach to a problem, it shows low flexibility. People trying to draw various lines, but all within the perimeter, experience functional fixity. Those with flexible thinking, on the other hand, will try varied approaches. They may try lines within the perimeter at first; however, the next attempt would reflect a different approach with lines outside of the perimeter, which is the way to find solutions to the nine-dot problem (see Fig. 1).

Functional fixity restricts people from having diverse approaches to problems because of preoccupation with previous experiences and conventional thinking. Extensive knowledge in a domain can be helpful but does not guarantee creative ideas. In fact, it may hinder flexibility and the creation of diverse ideas or solutions. Thus, it can be described as a cost of expertise in some cases. It is clear that flexibility is crucial to insight in problems, as well as divergent thinking tasks.

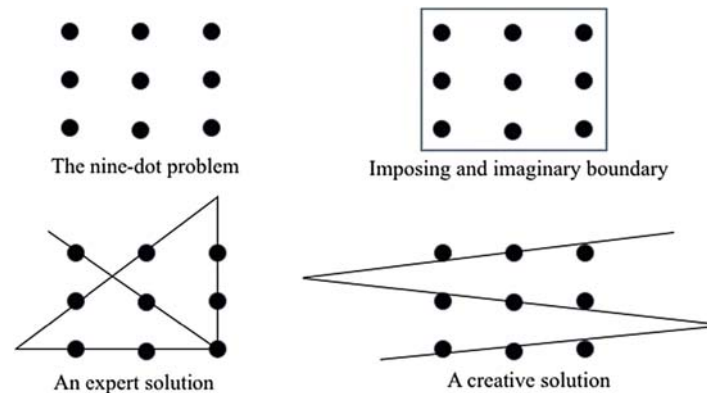


Figure 1 Conceptual blocks in the nine-dot problem.

Flexibility as Personality Trait

The relationship between personality and creativity has been studied extensively. Evidence reveals that certain personality traits are closely involved in the creative process. However, ambiguity still exists about personality as the direct and primary cause of creativity. Research indicates that various traits have a role in enhancing creativity. These traits include flexibility, risk taking, delay of gratification, preference for disorder, stimulus freedom, functional freedom and psychological androgyny. A meta-analysis by [Feist \(1998\)](#) indicated that creative individuals are more autonomous, hostile, dominant, impulsive, confident, extroverted, and open to new experiences. Other traits commonly associated with creativity include tolerance for ambiguity, independent judgment, ambition, perseverance, nonconformity, self-confidence, motivation, and initiative.

Flexibility can manifest itself as an attitude, which may be described as “a lasting tendency or acquired predisposition to evaluate a person, event or situation in a certain way and act accordingly” ([Vander Zanden, 1990](#), p. 19). When a person has a creative attitude, he or she has an inclination to think and act with a certain degree of flexibility and use unconventional methods while trying to solve a problem. Realizing all the components of a problem, and being aware not only of his or her own point of view, but also those of others can help produce creative solutions. Modifying strategies and lines of action to recognize and solve a problem is an indicator of the creative attitude. This creative attitude may emerge in various field of knowledge including artistic, scientific, cultural, and even in everyday life. Therefore, flexibility supports adaptability by providing options.

Frank Barron found that writers as a class are significantly more flexible than most people, and that creative writers who have achieved renown are 84% more flexible than the general population. On average, artists and scientists are more flexible than non-artists and non-scientists. Maintaining a certain direction for a long period of time, when the target is not always visible or contains many uncertainties, requires an extraordinary adaptive ability and a particular coping strategy. At this point, being flexible helps by changing one’s strategy in solving a problem or doing a task, changing the direction of thinking or even changing the problem itself. [MacKinnon \(1978\)](#) found that creative architects, more often than those less creative, reported turning to another activity when seriously blocked in a task and returning to it later when refreshed. Less creative architects, on the other hand, more often reported working stubbornly on a problem when blocked in their attempts at a solution.

Flexibility and Development

Flexibility may be tied to developmental experiences that enhance creativity. For example, evidence has revealed a reciprocal relationship between playfulness and creativity. Playfulness is one of the critical human traits of creative personalities. It is obvious that many scientists, artists, and composers, known for their creativity, are also playful ([Bateson, 2015](#)). Playfulness can be described as approaching situations in an exploratory manner and seeing the lighter side of a challenge with a sense of humor (see [Play](#)).

Playfulness, as associated with a positive mood, can stimulate creativity. Furthermore, different aspects of creativity may be affected by playfulness, or a positive mood in general, in different ways. For instance, playfulness enhances flexible thinking along with originality and fluency. Playfulness or the predisposition to engage in symbolic play has been associated with a high level of fluency in children. Playful behavior or playful thought helps generate new approaches to problems. The more playful children are, the more they are creative. Based on studies of kindergartners, high school students, and adults, it appears that playfulness and the flexibility it supports become part of an individual’s personality and are an essential ingredient in creative thought ([Alcock, 2007](#)).

Play as an important form of behavior facilitates creativity during the lifetime of each individual. It is evidenced that children’s play experience and their subsequent creativity are clearly intertwined. For example, the children with more opportunities to play achieve significantly higher scores on creativity. Engaging in extensive imaginary play during childhood has relevance to the creativity of those who are honored for their creative work as adults ([Root-Bernstein and Root-Bernstein, 2006](#)). Children who have spent time playing tend to be more creative on tasks they do immediately afterward than those who go directly from one task to another.

Flexibility is also related to sex role identification, which is learned first in families and then reinforced by the social environment and culture. Sex roles are a substantial part of an individual's belief system, whether or not he or she is creative. Apart from traditional male and female sex roles, a new sex role has been identified with has implications for creative thinking. Known as psychological androgyny, it refers to a kind of eclectic combination of both feminine and masculine behaviors. These people have above average male and female elements in their personalities. Androgyny is not a midpoint between the traditional sex roles. Rather, it includes elements from each of the two poles of masculinity and femininity, thereby becoming a higher level of sex role identification (Bem, 1974).

Sandra Bem (1986) illustrated the relationship between androgyny and creativity. Highly conventional people usually shy away from androgynous behaviors and have rigid sex roles. People with such rigid sex roles have conflicts accompanied by stress, which causes a great expenditure of energy. Bem outlined that having a traditional sex role as a form of rigidity may be detrimental to personality. If an individual is too strongly socialized to act in terms of a strict sex role, his or her creativity is likely to be inhibited. She concluded that as androgynous individuals look for a truly appropriate course of action without sticking rigidly with a role, they are far more functional. Such functionality fosters flexibility and creativity, accordingly. Her research concluded that androgynous individuals' scores on a measure of cognitive flexibility are higher than those who are feminine or undifferentiated. This is also supported by Csikszentmihalyi's (1996) findings about the paradoxical balance of masculinity and femininity. Importantly, the psychologically androgynous person is likely to be psychologically healthy, as well as creative.

Another developmental issue involves open-mindedness, a personality trait generally associated with flexibility. Open-mindedness has been described theoretically and empirically as a general disposition for creativity. It has been frequently evidenced to be positively related to divergent thinking. It is a strong predictor of divergent thinking, everyday creativity, and creative achievement. Those who are open minded have an ability to receive new information without prejudice. They tend to be imaginative and curious; thus, it is not surprising that open people are more creative. Creative people, on the other hand, tend to treat the new and different as a challenge rather than a threat. It seems that openness is the breadth, originality, and complexity of an individual's mental and experiential life. The mind open to new experiences and ideas more likely attains an insightful understanding, flexible thinking, and creative outputs.

Open-mindedness emerges in childhood and develops as a trait through adulthood. Parenting style seems to play a substantial role in the development of open-mindedness. Children encouraged by their parents to be adventurousness, risk takers, and assertive develop flexible personalities. Growing up in diverse cultures or experiencing diversity in different aspects of life may also help people to be open minded and, accordingly, cultivate their flexibility. Open-minded individuals with flexible personalities have a tendency to be less rigid, less neurotic, and less anxious than most.

Summary

Flexibility is an important dimension of the creative cognitive process as seen in the divergent thinking model. It has been evidenced that creativity needs flexibility, and creative people are generally flexible and adaptable. It is clear that flexibility is useful for insight into problems, as well as in divergent tasks.

Flexibility is needed for real world problem solving. When faced with a problem or issue, having diverse approaches or solutions rather than sticking with only one solution (fixity) is an obvious benefit of flexible thinking. Many real-life problems require people to go beyond conventional ways of thinking and break standard patterns. For example, when there are not enough ingredients to make dinner, when you have no money to watch a game, or when you need to convince a stubborn friend, you need to diverge from the common ways of thinking and vary your approach for a solution. This is possible through flexible thinking.

Flexibility as a personality trait has a role in promoting creativity. Flexible personalities are mostly open-minded. Besides, flexibility as an attitude allows people to become aware of all the components of a problem, and not just stick on one of the parts. Those with flexible personalities tend to be less rigid, less neurotic, and less anxious than most.

Flexibility is also related to developmental experience. Playfulness as a part of an individual's personality fosters flexibility and creative thinking, accordingly. Psychological androgyny as a type of sex role identification cultivates flexibility and the search for the truly appropriate course of action; therefore, it fosters creativity and allows an individual to be more functional.

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Flow

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Flow as Optimal Experience

It is what the sailor holding a tight course feels when the wind whips through her hair, when the boat lunges through the waves like a colt – sails, hull, wind, and the sea humming a harmony that vibrates in the sailor's veins. It is what a painter feels when the colors on the canvas begin to set up a magnetic tension with each other, and a new *thing*, a living form, takes shape in front of the astonished creator. Or it is the feeling a father has when his child for the first time responds to his smile.

Csikszentmihalyi (2008, p. 3)

The concept of flow which Csikszentmihalyi vividly describes above was introduced into psychology in 1975 culminating in his seminal work *Flow: The psychology of optimal experience* (Csikszentmihalyi, 2008). In his study of high-performing individuals from a range of domains, Csikszentmihalyi found flow in sports activities, games, rituals, professional activities and in artistic creations, when he asked his interview partners to describe the optimal experience, which made them feel happy and kept them motivated. Their optimal experience included a sense of effortless action, as if nothing else seemed to matter, and the experience itself was the whole. In such moments, thoughts, feelings, wishes, and action are in concert (Nakamura and Csikszentmihalyi, 2011). Put in general and abstract terms, being in flow represents a duality of performing and feeling at a peak level.

The flow experience is often paraphrased in everyday language as 'being in the zone', 'being on the ball', 'being in the groove', 'being in ecstasy', 'being lost in the moment', 'aesthetic rapture' or 'a magic moment'. This optimal experience is not static but on the move from one moment to the next, in which people feel no distinction between self and environment. In flow, past, present, and future seem to conflate.

Flow is an experience of total engagement in an activity and refers to a blissful state of intensified consciousness that occurs during an optimal experience. In flow, people feel simultaneously efficient, motivated, and happy (Moneta and Csikszentmihalyi, 1996). They experience a sense of control over their own actions and operate at full capacity. This optimal experience occurs when cognitive, physiological and affective aspects are brought together and a person's mind and/or body are stretched to the limit (Csikszentmihalyi, 2008).

Flow is rarely perceived by people during passive episodes or moments. It occurs, for example, when people are doing their favorite activities, at a level that is challenging, but not overwhelming. Flow occurs at varying levels of intensity and ranges from microflow in daily activities to intense flow experiences, the latter of which are usually experienced less frequently in life. Flow experience requires activity and the level of flow experience is dependent on how much the activity is intrinsically motivating and rewarding in and of itself rather than its outcome. However, flow can be experienced in an activity, which is not intrinsically motivated at first. A person could be assigned to a task and become completely involved in this activity so that the initially extrinsically motivated behavior could become intrinsic during its performance.

Since the 1970s, flow has developed into an interdisciplinary research field with published overviews in fields including psychology, sociology, sports science, management, and organization studies. The concept of flow is a significant starting point for the more recent discipline of positive psychology. It is important to note that flow is not only a meaningful research concept, but also a phenomenon which can easily be comprehended by most people by relating it to their own experiences.

From the beginning, flow and creativity have been closely intertwined, as exemplified in Csikszentmihalyi's publication from 1996 *Creativity: The psychology of discovery and invention*, in which he studied exceptional cases of individual creative work (Csikszentmihalyi, 2013). As creativity is an essential factor in all human progress and flow is a significant driving force of creativity, their close relationship makes the study of creative flow important. In contrast to flow in general, creative flow involves the search for discovery and novelty.

In a study about flow in work and leisure, Csikszentmihalyi and LeFevre (1989) found that creativity was self-perceived at higher levels in flow than in non-flow, and that above-average levels of creativity were reported during work flow. However, the exact relationship between flow and creativity is still under investigation, especially the question of whether flow is a precursor, a mediator or a parallel phenomenon to creativity and to what extent creative flow is related to creative outcomes.

Components of Flow

Although it is generally agreed that flow is a higher order construct, research varies concerning which components contribute to flow (Nakamura and Csikszentmihalyi, 2011). Based on an analysis of several interviews, Csikszentmihalyi's (2008) findings indicated that individual, social and cultural differences have very little impact on the flow experience, suggesting that the phenomenon in terms of how it is experienced can be regarded as nearly universal across socio-cultural settings. He came to the conclusion that the flow experience consists of the following eight components, 1 to 3 being pre-requisites or proximal for flow, 4 to 8 being elements of being in flow:

1. Balance between the level of skills and challenges: The fundamental component to reach flow in a specific activity is a bundle of opportunities that requires fitting skills. For those individuals who do not have the appropriate skills, the activity is not challenging.
2. Clear goal in the activity: There has to be a defined purpose and a precise idea of what to do next. Although the activity advances towards the final goal, the activity is driven by the realization of the next small goal.
3. Immediate feedback: While engaged in the activity, immediate feedback is necessary to make adjustments in order to reach the goal. Feedback often happens in real time without it being necessary to stop the activity.
4. A high degree of concentration: In flow, people's mental awareness is reduced to performing the activity, to the point where they may forget about general physical and mental needs. People in flow maintain focus with all their attentional resources on the relevant aspects of the goal and exclude distractions. A merging of action and awareness is essential to experiencing flow, such that any reflective thoughts that detach the person's awareness from the activity, for example, asking "How am I doing here?", will disrupt their flow.
5. A loss of self-consciousness: During a flow experience, people forget themselves and are so involved in the activity that they require most of their mental resources. People lose their worries how they appear to others.
6. A loss of sense of time: People forget the time during the flow state. Time seems to pass really fast when people are performing activities in which they are highly engaged.
7. A sense of control: In flow, people do not worry about a possible loss of control and even failure are taken into account. All external elements are less relevant because people are deeply engaged in the activity and can in general deal with the situation.
8. Autotelic experience: Flow is a happy experience which is intrinsically rewarding whereby the reward is directly connected with the activity. People are motivated by a strong wish to do the activity and reach the goal.

The flow experience is a function of challenges and skills in a specific activity. Therefore, the flow experience is dependent on the task, the situation in which it is experienced and the person's specific skill level (Nakamura and Csikszentmihalyi, 2011). The fundamental idea that flow is only experienced, when challenges posed and accessible skills are adequately matched and above average, is profoundly illustrated in Fig. 1. Boredom occurs where the challenges do not match the skills, and a region of anxiety exists where challenges exceed the skills. A balance of below average challenges and skills does not lead to flow but to an experience, which could be described as apathy. Its dependence on skills and challenges suggests that flow experience varies during an activity and between activities and, thus, should not be viewed as a state of high temporal stability. Moneta and Csikszentmihalyi (1996) noted that flow does not impose a maximum or equilibrium point to be perceived by the individual and that flow is fleeting and usually increasing over the course of an activity.

The intensity of the components of flow is perceived subjectively and, therefore, individual flow experience is highly personal. Correspondingly, the range of possible intensities of flow differs between people and situations. In addition, the environment and how it fluctuates influence the intensity of the components of flow, therefore, the flow experience should be regarded as a compound or holistic sensation (Nakamura and Csikszentmihalyi, 2011). Flow's interdependence with the environment is a key characteristic shared with creativity.

Empirical evidence showed that the components of flow positively correlate during the flow experience, but their strength and importance can vary. In empirical studies, Moneta and Csikszentmihalyi (1996) as well as Primus and Sonnenburg (2018) confirmed that four indicators, namely concentration, happiness, wish to do the activity and involvement adequately reflected individual flow feeling. Both studies confirmed that the four indicators were positively correlated to the individual flow corridor, reflected by balance and depth of challenges and skills.

Group Flow

The concept of individual flow has subsequently been expanded to the group level. While individual flow describes a state of consciousness within a human being, group flow is an emergent phenomenon of the group as a collective property. It is important

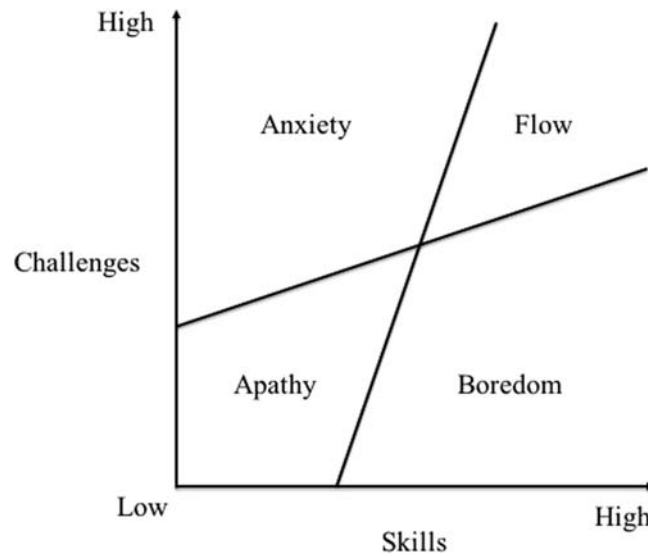


Figure 1 The flow corridor based on Csikszentmihalyi (2008).

to note that in flow the group has autonomy and authority during the group activity. In group flow, every individual contribution seems to come naturally. Each member feels as if all group members are able to anticipate what their fellow agents will do before they even do it.

The possibility for high group flow is increased when the level to which the group has to attain a collective goal is matched by a number of pre-existing structures shared and used by the members like an overall outline, a shared knowledge repository, clearly defined roles, and a common agreement on the conventions (Sawyer, 2003). The following seven components are indicators of group flow:

1. Constant communication: During the group flow experience, all members are always talking and interacting with each other.
2. Close listening: In group flow, no member plans ahead what is to be said so that each contribution is a genuinely unplanned response to what has just been said.
3. Blending egos: Each member has the possibility to contribute to the group flow. At the end, no one can remember who contributed what to the group flow.
4. Equal participation: To reach a peak performance, each member participates equally which requires in general that everyone has a similar level of expertise and authority. However, the expertise should not be too familiar to enable unexpected connections that result in new ideas.
5. Complete concentration: The group is fully engaged in the task with all their resources and without external distractions.
6. Moving the activity forward: In group flow, each member builds on the ideas by the others and elaborates these ideas further.
7. Importance of the activity for each group member: Even if the relevance of the task emerges during the group activity, all members need an intrinsic motivation and a wish to do the activity.

As a result, groups in flow are in “interactional synchrony” (Sawyer, 2003, p. 43), which can be described in everyday language as having ‘good chemistry’ between the group members during the activity. Groups attain and keep the flow at a peak level by staying in interactional synchrony, which pianist Franklin Gordon described: “Every musician wants to be locked in that groove where you can’t escape the tempo. You’re locked in so comfortable that there’s no way you can break outside of it ... It doesn’t happen to groups every single night ... But at some point when the band is playing and everyone gets locked in together, it’s special for the musicians and for the aware, conscientious listener. These are the magical moments, the best moments in jazz” (Berliner, 1994, p. 388). Fig. 2 describes how people get locked in together during a group activity. It has to be emphasized that no two-dimensional figure can adequately illustrate the complexity of real-time interactional synchrony. This figure simply illustrates the process by which group members can get involved into the group flow during the activity.

The horizontal axis, interactional time, represents the permanently changing nature of $E(t)$ which is the group emergent active for a specific flow time. Each individual act during the activity is dependent on several interactional factors, which is illustrated by the example of Agent(1). The emergent $E(1)$, which is the shared property of the whole group at a specific moment in time, affects Agent(1) in the form of linguistic prerequisites, which inspires Agent(1) to develop something new which flows into the interaction process as a linguistic consequence for the other group members. The group itself decides during the flow experience what portion of the linguistic consequence leads to $E(2)$, which is then the new group emergent influencing all group members (in this example $A(2)$) to develop something new.

Sawyer (2003) described the emergent $E(t)$ which changes all the time during the group activity as follows: “The emergent is structured but ephemeral, changes with each performance act ... It is an emergent social fact; it is not determined by any single

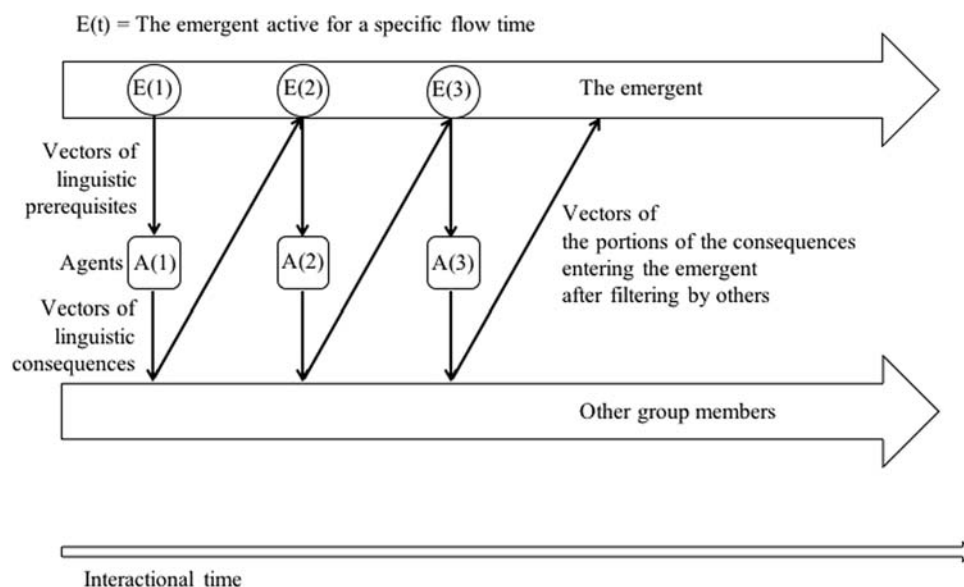


Figure 2 Group flow during the activity based on Sawyer (2003).

performer, and only partially constrained by the genre definition. For the interaction to continue as an intersubjective shared activity, the performers must work together in creating the emergent" (p. 87). Members in highly interdependent groups serve as agents of flow for each other and, therefore, group flow is perceived as more enjoyable than individual flow.

While individual flow has been comprehensively studied, the empirical analysis of group flow and, in particular, the interrelation between individual and group flow during a creative activity is just beginning. A positive correlation between individual and group flow can be expected such that when a group is in flow, it is highly likely that its members experience individual flow. In fact, Primus and Sonnenburg (2018) found empirical support that group flow is associated with the individual flow of the group members in a partial least squares (PLS) analysis of experience data from Design Thinking teams. Their results indicated that group flow is positively correlated with the individual flow corridor experience, as well as with the construct of individual flow feeling, reflected by concentration, involvement, happiness and wish to do the activity.

Measurements of Flow

Although research strongly agrees on the definition of flow itself, there is a dispute concerning the measurement of flow. Several self-report tools have been designed to approach this inherently unstable and subjective experience whereby the dominant research methods in literature are interviews and questionnaires.

The original concept of flow emerged out of in-depth qualitative interviews about the nature of the experience, when a specific activity is going well. Interviews provide holistic insights of the flow state in real-life context. In the beginning of flow research, interviews were an important tool to identify the components and dynamics of flow as well as to set the ground for wider based quantitative assessments. Interviews showed that people in all accounts of life felt a flow peak when they were being the most creative. Interview studies are still used to examine flow experience.

First approaches to measure flow with questionnaires started with paper-and-pencil tests. The aim of using questionnaires was to measure the occurrence of previously identified components of flow across individuals and contexts. The paper-and-pencil tests, which today are predominantly web-based, present respondents with several passages describing the flow experience and ask them whether they have had the experience, how often and in what context (Nakamura and Csikszentmihalyi, 2011).

Csikszentmihalyi (2008) developed, applied and validated a novel method to continue his research on everyday flow experience. This approach is based on the experience sampling method (ESM), in which individuals are equipped with a pager that prompts them to complete a questionnaire at several random times throughout the day. Participants answer a set of questions to describe the moment at which they were signaled, about what they were doing and how they felt. The ESM allows intrapersonal and interpersonal comparisons of the flow experience across times and various accounts in life. Unlike interviews and paper-and-pencil tests, the ESM focused not only on the original components of flow experience, but also on other cognitive, emotional, and motivational states, which led to refinements of the components and dynamics to build a systematic flow concept.

Interview and questionnaire approaches are limited by a potential disturbance of the flow state through interruption or by reliance on retrospective reconstruction of the flow experience. This criticism has some truth, but it does not mean that the measurement of flow using interviews or questionnaires is not valid. Even if a respondent is out of flow, she or he can still remember what

she or he has done and felt before. This situation can be compared with a dream. When you wake up, you stop dreaming, but you can still remember content and feelings of the dream and report them.

In recent years, experimental designs with controlled variations of test conditions have played an important role in gaining a deeper understanding of changes in the flow experience during an activity (Moller et al., 2010). For example, games were used to observe, control, induce and vary flow in lab settings. In a one-day experiment, Primus and Sonnenburg (2018) compared the intensity of the flow experience at the individual and group level across different Design Thinking activities and different test groups. EEG as a biometric measurement of the affective states of people gained methodological significance as a way to investigate the relationship between brain waves and the flow experience (Wanga and Hsu, 2014).

Directions in Flow Research

Flow has been developed into a robust concept for research and theorizing. Although it is regarded as a well-founded concept, the investigation of flow together with components related to the interaction of humans and the environment still shapes or adds new components without completely changing the basic understanding. The flow experience is almost identical across lines of culture, class, gender, and age as well as across different kinds of activities. The possibility to experience flow seems to be nearly universal but people vary widely in the frequency and intensity of the reported flow experience.

Classical domains of flow research are science, music, art, dance, writing and religious settings. Further important domains are sports, learning in educational settings, therapeutic settings, game-based learning as well as areas of work. The majority of flow research has focused on activities with clear goals and standards of success which can be monitored and easily regulated. It is noteworthy that some studies approach the negative effects of flow like addiction when exercising or playing video games as well as impaired risk perception and risky behavior (Schüler, 2012). Across domains, the following dimensions are of particular importance:

- Periods and patterns: Flow occurs more often in work than in leisure as work is more related to challenging activities which promote personal growth as well as a successful and fulfilled life. In contrast, the intensity of flow is higher during leisure activities and the level of flow tends to increase at the end of the day and is higher during the weekends. In the relationship between work and leisure, Csikszentmihalyi and LeFevre (1989) identified a paradox that people have more positive flow feelings at work, but also a higher wish to do something else.
- Context and resources: The flow experience is strongly influenced by situational characteristics, which are even more important for flow than personal characteristics or preferences (Fullagar and Kelloway, 2009). Especially autonomy during the activity is a significant predictor for flow. In an educational setting, Bakker (2005) figured out that job resources like autonomy as well as performance feedback, social support and supervisory coaching had a positive influence on the balance between challenges and skills and were positively related to the flow experience of teachers. In addition, flow passed from teachers to their students which illustrates the fluid transition from the psychological to the social dimension of flow.
- Individual attitudes: The need for achievement guides the experience in the flow corridor, even more, a strong need for achievement facilitates reaching higher levels in the flow corridor. When perceiving high challenge and high skill, employees with a strong need for achievement show greater positive mood, intrinsic task interest and greater spontaneity. A positive or spiritual attitude towards life has a positive impact on flow. Kauanui et al. (2010) found out that spiritually connected entrepreneurs experience flow more frequently and provide more likely a creative and playful work environment.

A more recent research direction focuses on the promotion of flow. The goal is not to directly promote the flow experience, but to shape activity structures and environments as well as assist people so that flow is fostered. According to Csikszentmihalyi (2013), it is challenging to make flow happen, but it is possible to learn how to get a mental attitude to approach flow.

With appropriate training, people can develop techniques to reach and stay in flow. For example, a level of daily training is necessary for musicians to be prepared for flow during the performance. On the empirical front, Primus and Sonnenburg (2018) showed that Lego-based activities can be used as a warm-up technique to foster the creative flow on an individual and group level. In particular, athletes have developed warm-up rituals. Here is one described by grand slam tennis champion Rafael Nadal: "Forty-five minutes before facing Federer I began the last phase of my pre-game ritual. I took a cold shower. Freezing cold water. I do this before every match. It's the point before the point of no return. Under the cold shower I enter a new space in which I feel my power and resilience grow. I'm a different man when I emerge. I'm activated. I'm in 'the flow', as sports psychologists describe a state of alert concentration in which the body moves by pure instinct, like a fish in a current. Nothing else exists but the battle ahead. ... I put on my earphones and listened to music. It sharpens that sense of flow, removes me further from my surroundings." (Nadal and Carlin, 2011, pp. 11–12)

Gaps in Flow Research

Although the concept of flow has developed into a hot topic in research and practice, the quite narrow analytical perspective does not help to evaluate flow in its essence. More research is required to analyze the flow experience from a holistic and complex

perspective that sheds light on flow as a dynamic body-mind-construct in interplay with its environment. In addition, it is necessary to integrate and differentiate the state of flow regarding other positive states like mindfulness, meditation or peak performance.

The flow experience fosters individual and group creativity but much more theoretical and empirical work on the relationship between being in flow and (the process of) engaging in a creative activity is necessary to explain the relationship between these constructs. In comparison to other kinds of flow, creative flow is more defined by unclear goals, uncertain feedback and the possibility of surprise.

Empirical research should investigate individual and group flow over time, especially the changes of flow levels during a creative activity. Although flow has a tendency to be unstable, researchers need to understand more about the maintenance and increase of flow in a specific situation. In particular, the link between flow levels during a creative activity, the creative process and the creative outcome have not been sufficiently defined. In this context, it would be useful to study the impact of breaks and fatigue as well as warm-ups and incubation during creative activities.

In addition, future studies should focus more on the creative process itself, as flow may happen anywhere in the stages of the creative process. Individual or group flow may follow after a period of hard work, during incubation, parallel to an insight or in an elaboration of the idea. Research should also include an objective assessment of the creative performance in addition to self-report measures and use more experimental settings in order to control external influences and to examine the flow experience during and directly after it happens. Although it is difficult to inspire flow under controlled conditions, neuroscience research may also provide valuable information regarding flow states.

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Four Ps of Creativity: Person, Process, Press, and Product[☆]

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Glossary

Alpha Press refers to environmental pressures that have an impact on behavior independent of the individual's interpretation of them.

Beta Press refers to environmental pressures that have an impact on behavior, if the individual perceives and assigns meaning to them.

Five As is an abbreviation for Actor, Action, Artifact, Audience, and Affordance, a re-organized framework for the study of creativity development

Four Ps is an abbreviation for Person, Process, Press (or place), and Product, a conceptual framework for the study of creativity.

Persuasion refers to methods or approaches that creative individuals use to create products that change the way that people think.

Potential refers to the latent capacity of something such as creativity to manifest itself.

Introduction

There are many different approaches to understanding creativity. For the past five decades scholars from various domains such as education, engineering, music, art, and entrepreneurship research have considered creativity an important aspect of their discipline. Creativity, which may represent the most fundamental human capacity, is impossible to define with a few simple words. The complex aspects of creativity have led numerous scholars to build up comprehensive frameworks that (a) describe what creativity is, (b) explain how creativity can be developed, (c) discern creativity levels, and (d) clarify why some ideas or products are more creative than others. In 1961, Mel Rhodes published *An Analysis of Creativity*, which is still widely cited by writers who attempt to define the concept of creativity or to articulate the meaning of creativity and its development. In this review, Rhodes' Four Ps of creativity will be explored in detail along with other frameworks based on the Four Ps such as Runco's Hierarchical Theory of Creativity (2007, 2008) and Glăveanu's 5 A's framework (2013).

The Four Ps

When he published his classic article in 1961, Rhodes had collected over forty definitions of creativity in order to map out a concept of creativity. He analyzed his findings on creativity by using the metaphor of a "prism." When light passes through a prism, it presents a rainbow of colors. Like sunlight, when creativity is viewed through the prism of analysis, it will show four different strands which are *Person*, *Process*, *Press*, and *Product*. Rhodes called them the four P's of creativity. He also stated that "Each strand has unique identity academically, but only in unity do the four strands operate functionally." (Rhodes, 1961, p.307). Each of the Four Ps represents a unique perspective on creativity, and the four Ps play compete a concept of creativity that is useful. Each strand might be stressed a bit differently in diverse endeavors; that is, Rhodes' definition has the flexibility to be functional across academic domains.

[☆] *Change History*: April 2019. Daehyun Kim updated the text throughout the article.

This article is an update of M.A. Runco, D. Kim, The Four Ps of Creativity: Person, Product, Process, and Press, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 534–537.

Person and Personality

Rhodes defines *Person* as the information about “personality, intellect, temperament, physique, traits, habits, attitudes, self-concept, value systems, defense mechanisms, and behavior” (Rhodes, 1961, p. 307). It is a common perspective to think that creative individuals have similar personality profiles supporting their creative behaviors. Researchers have tried to identify the core characteristics of creative people, so that a general profile of a creative personality might be used to enhance the diverse domains. Creativity has been associated with openness to experience, robust imagination, intrinsic motivation, divergent thinking, nonconformity, and risk-taking. Of course, these are identified as tendencies. That is, it is not guaranteed that if a person shows these traits he or she will be a creative person. Additionally, it is not guaranteed that if a creative person expresses some creative traits that he or she will continue to demonstrate creativity. In fact, if a person shares some features of the creative profile it means that he or she may have creative potential. That potential could bloom when the person is in the right environment where he or she is able to develop and perform. In other words, there are personality attributes that creative individuals share and those attributes can be nurtured when environments are conducive to creativity. This scenario of potential and environment is called Trait X State interaction in personality psychology. Actual behavior is controlled by both personal traits and situational states, not just by one or the other. Also, creative individuals from different domains could show variations in their creative traits. Someone who is creative in the arts may be very different from a person creative in math, science, or engineering. In fact, there is no set creative profile that identifies creative individuals in the various domains.

The Creative Process

The *Process* approach to creativity is about how individuals generate original ideas or solutions when they are faced with questions and problems; whereas, the *Person* approach focuses on who is creative. The *Process* approach seeks to capture motivation, perception, learning, thinking, and communicating (Rhodes, 1961, p. 308). Researchers and educators have questioned whether individuals go through similar process to generate creative ideas, or if it is the opposite that the creative process is different for each person. In addition, it remains to be seen how the creative process differs among individuals and if creativity can be taught. Is the creative process specific to the individual? In early 1926, Graham Wallas outlined the four stages of a creative process in his book *The Art of Thought*: preparation, incubation, inspiration, and verification. This four stage model described the creative process as a conceptual anchor. In the *preparation* stage, individuals define problems and gathers information through a composition of observing, listening, asking, reading, collecting, comparing, contrasting, analyzing, and relating all kinds of objects and information (Rhodes, 1961, p.308). The second stage, *incubation* is a period that allows individuals to take time away from the task or problem, so that they may contemplate a wide range of options and solutions for the problem. Individuals can benefit from being relaxed and unrestrained during incubation. The length of incubation depends on each individual: it could last minutes, days, and even longer. *Illumination* is the third stage where the insight actually makes itself know. There is an “ah ha” or “eureka” moment as different ideas and new directions pop into consciousness. Interestingly, the sudden appearance of an idea may imply that insights are quick or sudden, but Howard Gruber’s careful research on discovery indicates that they actually are protracted and take time. Since the person’s thought process is in the incubation stage, he or she is not directly conscious of working on the topic. He or she does not realize that insights are protracted. They may feel sudden, but actually a period of time has passed. The last stage is *verification*. Here the idea is tested and applied. The individual might revisit earlier stages if they think the ideas need more preparation or more time for incubation.

Press Factors

Rhodes referred to *Press* as a term that alludes to the relationship between human beings and their environments. Henry Murray seems to have gone into the most detail about Press factors and distinguished between alpha and beta presses. Alpha press refers to the total objective world. On the other hand, beta press refers to that segment of the objective world that the individual interprets as significant. For example, loud noises lead to reactions and can be distractions to anyone. A certain music can be appealing to someone, but esthetically not appealing to another. Many environmental factors depend on interpretations. Most environmental influences on creative behavior are more beta than alpha press. Many Press aspects have been examined including classroom environment and organizational setting. Resources such as material resources and social resources are quite important. Time is especially important, in part because original ideas may require incubation or at least time for free association and the consideration of alternatives. Time is an example of a social press, because people can be under pressure to complete a project or article before some stated deadline. Some people work well under pressure, they concentrate their effort and can be positively motivated by time limits. Others might prefer to take more time and are distracted by deadlines. The key social press factors include support for new ideas, challenges, trust and permissiveness, and latitude that supports risk taking. Ruth Richard, in her article about the 4Ps that appeared in the first edition of *Encyclopedia of Creativity*, pointed out that it can be difficult to support innovation and creativity in some settings, including

educational settings. In public schools it is challenging to address each students' uniqueness while at the same time addressing the mission of the school system that must satisfy state and federal policy directives. In fact, some environments can limit creativity. Educators must have clear objectives and objective assessments that encourage students to engage their innovative and adaptability capacities, which are the benchmarks of creativity.

Products

Rhodes refers to *Products* as tangible forms manifested from ideas. Ideas are thoughts that are communicated through various mediums. That is, creative products may be novels, poems, scholarly articles, art works, paintings, designs, inventions, or patents, or they may take another form such as performance. Performances are not static forms, but they can still be counted as creative products. Products allow for objective analysis. The problem is that they may not be very predictive. Sometimes, the past is indicative of future efforts, but not always. Additionally, products say little about the actual creative process. In fact, some studies of creative products have focused on examining the product itself rather than the creative process or the talents and effort that went into the product. For example, The Creative Product Matrix contains a list of dimensions that allows for the comparison and ranking of various kinds of products. Many studies of creative products involve eminent persons or experts. This makes sense because they are likely to be creatively productive. Consider, for example, the research on scientific creativity. Products may be publications and citations to them. The latter would be indicative of the quality of a scientist's work because higher quality research is most likely to be cited by others working in the field. Studies of publications as products suggest that there are advantages to interdisciplinary work – some highly creative scientist being polymaths (a person of wide-ranging knowledge or learning), and that a minority of the field produces the lion's share of the research. This last finding is known as Lotka's Law.

Hierarchical Framework for the Study of Creativity

Various lines of research have suggested that the initial creative insight, produced by an individual, is only one aspect of creative achievement. Clearly, there are social factors involved in creativity, and these social factors nurture the personal attributes and personal judgements that are needed to create a new idea or product. Dean Keith Simonton took a social perspective on creativity and defined it specifically in terms of "persuasion." An argument that locates persuasion as a major agent in our larger communicative world. Persuasion fits nicely into our alliterative scheme (as a fifth P), but more importantly persuasion acknowledges the influence of social and historical factors. Put simply, creative achievements change the way that people think and behave. Creative artifacts and performances are influential; they are persuasive.

Simonton's extensive empirical research on social factors also supports Lotka's Law but goes well beyond that. He has tested a large number of cognitive, developmental, and historical hypotheses and derived several compelling *nomothetic theories* about creativity and its impact. Nomothetic theories apply broadly, often across historical eras and, to a certain degree, across cultures. They parallel what are sometimes called universals and can be contrasted with *idiographic theories*, which focus on how individuals differ from one another. Persuasion is also assumed by social theories that focus on attributions as part of the creative process. Attributions of creative value may be given by judges and individuals making up a field of study. The idea here is that an individual may produce something with creative potential, but if judges do not attribute creativity to it, very likely it will have no impact and may very well be ignored and forgotten. If this line of thought holds up, there would be reason to direct one's creative efforts not just to the product, but also to impression management that will increase the likelihood of favorable attributions. This notion has been criticized since it suggests that an individual might benefit from taking time away from creative work so there is time to manipulate attributions. Still, case studies sometimes confirm that eminent creators tend to care a great deal about how their work is received.

Each of the perspectives reviewed in this essay have been organized into a hierarchical framework created by Runco (see **Table 1**). Of most importance is the placement of creative potential and creative performance at the top of the hierarchy. The rationale for this is that many factors, including those describing the creative person and the surrounding press factors, may influence creative effort, but these factors do not always do so. The person and the environment incubate creative potential, but they do not guarantee creative performance. Products, on the other hand, are an end result. A printed text, object, or performance exists in reality. Similarly, new ideas and products are only persuasive if they are complete, or at least manifest. There is a clear separation between perspectives on creativity that describe potential and those that describe actual performance. It is possible that a chronology of sorts can be hypothesized, with particular traits providing creative potential, which are then supported by various press or environmental factors. The results being that a product or performance is created and takes on the social attributes of creativity.

There are advantages to the study of the attributes categorized in **Table 1** as being indicative of creative potential. The table provides a chronology on how to activate potentials and increase creative productivity. The advantage of research on actual performance is that those attributes on the right side of **Table 1** are accessible to objective assessment. Different critical lens can be engaged to analyze a creative object as a social text. There can be consensus about creative things. The

Table 1 Hierarchical framework for the study of creativity

<i>Creative potential</i>	<i>Creative performance</i>
Person Personality Traits, characteristics, idiosyncrasies	Products Patents, inventions, publication, works of art Ideas
Process Cognition	Persuasion Historical impact systems Individual-field-domain Attributions and social judgement
Process Distal influences Evolution Zeitgeist Culture Immediate influences Environments and settings	Interactions State X trait Person X environment

problem with some performance approaches is that, to apply what is learned we must draw inferences from the past to assess the object or performance in the present and the future.

The Five A's Framework

In 2013, Glăveanu proposed the Five A's as a new conceptual framework to reinvestigate creativity: Actor, Action, Artifact, Audience, and Affordance. It extends Rhodes' famous theoretical framework the Four Ps (Person, Process, Product, and Press), which was published in 1961. Rhodes' theoretical work is widely cited and remains one of the fundamental theories of creativity. However, Glăveanu presents a more contemporary model. He acknowledges that Rhodes' approach remains fundamental to his own theory of creativity, which now incorporates a broad conception of social identity.

For decades researchers have attempted to add and elaborate on the definition of creativity based on the Four Ps. It was Glăveanu who was able to rewrite and reorganize the framework to include a broad contextual understanding of creativity. His framework presents an approach to creativity based on socio-cultural perspectives. Table 2 shows how each of the Five As are related to the Four Ps based on creative activity that develops within social and cultural contexts: from person to actor, from process to action, from product to artifact, and from press to audience and affordance. If the Four Ps were focused on elements that constitute creativity, the Five As go further by associating and analyzing the interaction between elements through the lens of sociocultural psychology. In fact, the Five A's suggest viewing and thinking about creativity within broader theoretical perspectives that include social roles and modes of communication.

According to Glăveanu, the concept of *actor* embraces social-cultural psychology whereas *person* covers only the internal attributes of the person. The actor is theorized to exist within social settings that included relationships within a human community. Personal structure should be understood and interpreted within social structure. Therefore, creative *action* is an embedded concept of interrelationship between creative actor and cultural and societal situations rather than creative process itself. That is, the actor cannot be understood separately, and he or she is simultaneously related to audience and societal affordances. Creative action appears out of the relations between actor and audience. These relations create artifacts and the artifacts also can mediate the relations between actor and audience. The dynamic interrelations and integration of each element with social and cultural context are presented in the five A's framework. The artifacts will vary based on how potential actors from the diverse domains interact with different degrees and levels of audience. Interactions between a classroom teacher and students to produce creative artifacts in a school environments differ from the relationships of world-class innovators and scientists who interact with audiences at different levels and distances. The Five A's framework can be applied to various modes and levels of creativity across diverse domains such as art, science, education, entrepreneurship, and so forth.

Table 2 Comparing the four P's and the five A's frameworks (Glăveanu, 2013)

<i>The four P's of creativity</i>		<i>The five A's of creativity</i>
Focus on: Internal attributes of the person Primarily cognitive mechanisms Features of products of consensus around them	Person → Actor Process → Action Product → Artifact	Focus on: Personal attributes in relation to a societal context Coordinated psychological and behavioral manifestation Cultural context of artifact production and evaluation
The social as an external set of variables conditioning creativity	Press → Audience → Affordance	The interdependence between creators and a social and material world

Conclusion

Six Ps (that is, person, process, press, product, persuasion, and potential) and the five A's of creativity are reviewed in this article. There are several intersections and shared points among them. For example, note that at the highest level product and persuasion fuse when considering eminent creators who have wide disbursement and social recognition. Personality research has identified several tendencies (e.g. flexibilities) that have also been uncovered in studies of the creative process. Research on Press and place points to factors in the environment that support the same traits. Importantly, environments that support creative efforts offer certain things and avoid others. Recognizing that there are both supports to creativity as well as barriers, suggests that both be taken into account when assessing creative efforts. Also recall that the impact of environmental factors are frequently moderated by perceptions and interpretations. These factors by definition are constructed by each individual, so it is difficult to make recommendations that apply across all people, settings, and organizations.

The hierarchy in [Table 1](#) is skeletal but nonetheless underscores the fact that some perspectives on creativity assume that only manifest performances are important, while others recognize the more personal side. It is possible to take both personal characteristics and creative performance into account by assuming a developmental process, which suggests that creative potential is a starting point. In summary, if the supports are present (perhaps from creative press and place) potential might be fulfilled resulting in actual creative performance. Creativity may be apparent in actual products and performances that have impacted and persuaded an audience to change its way of thinking. Consider the concept of *framing*. Framing occurs when individuals or activist attempt to change the perception of a problem in order to create new solutions or generate greater awareness. This brief review of the various perspectives of creativity provides a practical guide to recognizing and nurturing creative potential. It is to everyone's advantage if creative potentials are fulfilled and creative products and performances common occurrences. From the Four Ps to the hierarchy of creativity to the Five A's framework, theorizing creativity has broaden over the decades. These frameworks take into account a concept of creativity that stands on particular elements and extends into multidimensional approaches that place the individual in the context of society and culture. The Five A's framework does not specify exact relationships among the elements (actor, action, artifact, audience, and affordance). However, it may be meaningful for new research efforts to discern these multidisciplinary features within a sociocultural psychology analysis.

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Friendships and Social Networks

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Introduction

Creativity is an interpersonal, culturally based phenomenon (Glaveanu et al., 2019). Indeed, the creative process and final products created by a single person cannot be separated from their interactions with friends, family, collaborators, and the social context in which they were raised or currently reside. People rely on and collaborate with others to find important problems requiring solutions, gather information, generate and implement ideas, and for subsequent recognition for their ideas. Further, creativity acts as a form of communication and expression that further connects and binds people together. The relationships people form with others represent their own personal social networks. These personal networks are then embedded within the larger social networks of organizations, schools, or societies and the world as a whole.

To develop an understanding of the role of friendships and social networks with creativity, this entry defines what networks are. Next there is a discussion of the role of friendships and social networks for creativity focusing on both the advantages and disadvantages of five commonly studied aspects of personal social networks: network size, network strength, network diversity, brokerage, and network closure.

What Are Social Networks?

Social networks are systems that include “nodes” and connections among those nodes. *Nodes* can be various things such as people, schools, teams, organizations, websites, words, or neurons in someone’s brain. Most social scientists focus on the connections among people across various social systems within schools, organizations, and society more generally. Nodes differ from each other in various ways. If nodes are people, they might differ in characteristics such as sex, age, race, personality, political orientation, values, etc. Formally, the connections among nodes are called edges. *Edges* are also sometimes referred to as ties, connections, or lines. These interpersonal connections can be many different types and be separated into four main types: similarities, social relationships, interactions, and flows (Borgatti et al., 2009). Connections based on similarities might be due to location, different attributes, or membership in various social groups. Social relationships include kin, other roles (e.g., friends or coworker), affective (e.g., liking, disliking), or cognitive (e.g., knowing). Interactions deal with aspects like who talks to who or nodes helping/hurting one another. Finally, flow would be whether tangible or intangible goods (e.g., information, resources) are transferred. Edges can also go one or both ways. *Undirected edges* are those that go both ways. For example, if two people collaborated with one another the edge would be undirected. *Directed edges* are when the connection goes one way. For example, someone might share information with another person, but that other person does not share information back.

A variety of connections have been examined by social network researchers, including collaboration, friendship, knowledge sharing, violence, kinship, romantic relationships, nominations, and more. Although these different networks are often studied separately, there is overlap among them. For example, a friendship network might also overlap with different networks used for communication and collaboration.

Fig. 1 shows an example of a network of tweets from Twitter using a specific Hashtag from a conference on arts, emotions, and creativity. Next, the role of social networks for creativity are discussed with greater emphasis placed on friendship, communication, and collaboration networks as there is likely overlap between these networks and they are more commonly studied. Advantages and disadvantages with friendships as it relates to creativity are considered.

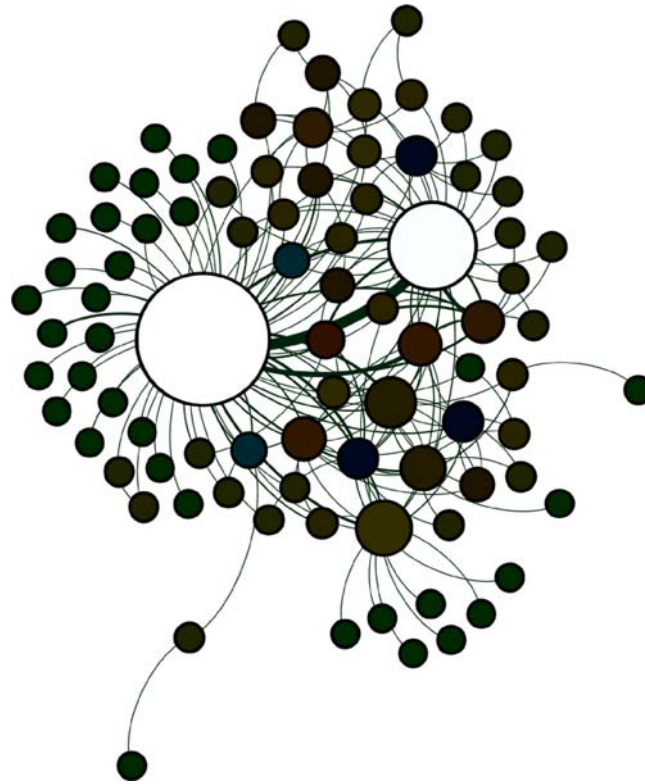


Figure 1 Tweets using the hashtag #artesemocionesycreatividad, which was the hashtag for a conference on arts, emotions, and creativity in Santander, Spain October 9–11, 2019. The tweets were acquired the evening of October 10th. Only 87 nodes and 191 edges are shown, which are those forming a giant weak component (i.e., all nodes within the network are connected to at least one other node in the network, regardless of direction). The two large white nodes represent the Botín Center and the Botín Foundation Twitter accounts. The black nodes represent other nodes using the hashtag. The size of nodes are weighted by network size (i.e., degree centrality). Although edges are directed, they are shown as undirected.

Role of Friendship and Social Networks With Creativity

Friends, provide opportunities for communication and collaboration as well as relief, opportunities to share experiences and information, and more. Simply put, they can provide comfort and a sense of belongingness. Further, friendships help with a person's individual and interpersonal creative endeavors.

An important question is how friendships and other relationships form. Typically, ties between people form through proximity and homophily (i.e., similarity-attraction; Kadushin, 2012; McPherson et al., 2001). Proximity deals primarily with geographical location among people. Two or more people are more likely to form social relationships that live in the same location, work in the same building or for the same company, attend the same school, and/or attend the same events. For children, relationships might also form based on playing together on the playground at school.

The formation and maintenance of friendship and social relationships also depends on homophily/similarity-attraction, following the adage "Birds of a feather, flock together." People that are similar to one another are more likely to create friendships, become close colleagues, form romantic relationships, and many other types of social network ties. The continuation of these relationships also depends on these similarities. The attributes include, but are not limited to the node characteristics mentioned above.

For creativity as a binding force, people seem to connect with people who are similar to them. There is a relationship between receiving similar scores on a creativity task and nominating other people as one's friend (McKay et al., 2017). People sharing a preference for engaging in creative activities appear to form and maintain relationship based on these similarities. Further, they might be more likely to attend similar events and enjoy similar activities and hobbies. Although these reasons likely drive this relationship, further research is necessary to determine why the formation of friendship has to do with creativity.

Social network and creativity researchers often study people's personal networks. That is, while many people make up a larger social network (called "whole networks"), often times the focus is on a single person's individual network (called "ego networks"). When focusing on the relationship between ego networks and creativity, it is more nuanced and complex than simply saying that social relationships are beneficial for a person's creativity because what represents a person's social relationships is complex. This entry focuses on five aspects of social networks and their relation to creativity: network size, network strength, network diversity, brokerage, and network closure. Each of these aspects and their advantages and disadvantages for creativity will be explored.

Network Size

One way to conceptualize how friendship relates to creativity is to consider the number of friends within a person's network. This is called *network size*, which is formally called "degree centrality" by social network researchers. Generally, the relationship between network size and creativity is positive (Baer et al., 2015; Kéri, 2011; McKay et al., 2017). That is, as the number of friends within someone's personal network increases so too does their creative performance. This positive relationship is due to a few related reasons. First, people have more opportunities and people to share and discuss information with. Because creativity involves obtaining information to generate new and useful ideas, people need to know what has been done before, what other similar people are working on, and what information they might need to know for their work. That way, they can create something novel and useful. Second, people have more collaborators they can work with. Creative work often involves lots of hard work and trial-and-error. Friends and colleagues help someone deal with the laborious effort creative work requires, speeding up the process to find a viable idea. Larger networks typically help people navigate the complexity that is creative work.

Although the relationship between the number of friends in someone's personal network and creative performance is positive, there are disadvantages to having a large personal network. With large networks, the time a person can devote to creative efforts can also decline. Although the help someone receives from others benefits their creativity, people must divert their attention to maintaining these friendships and colleagues. Although the time spent getting to know your friends and colleagues better – and your friend/colleague getting to know you better in return – is meaningful, it takes time and attention away from creative tasks or projects. This can result in creative work taking more time, rather than less. Additionally, people might receive lots of conflicting information, ideas, and suggestions from others. In such cases, deciding the best course of action with creative work is more difficult. In sum, there is a positive or inverted U-shaped relationship between network size and creativity. A large network can be beneficial to someone's creative work, but at a certain point too many friends and colleagues can become detrimental. There is no magic number that can be offered as it depends on a creator's personality and environmental factors (Baer, 2010).

Network Strength

In addition to network size, the strength of relationships within a person's network is important. *Network strength* focuses on the quality of relationships with someone's personal network. The strength of relationship within a person's network is based on three factors (Granovetter, 1973). First, closeness reflects the emotional closeness of relational ties. Second, duration reflects how long the relational tie has persisted. Last, frequency is how often people interact. Typically, ties are considered either "weak" or "strong." Weak ties are those people are not emotionally close with, have known for a short duration, and talk to infrequently. Strong ties are those people are emotionally close with, have known for a long duration, and talk to frequently. For younger children, strong ties might reflect who they play with on the playground regularly. For teenagers, it might be who they spend their free time with or eat lunch with. For adults, this might be who they spend their free time with and close colleagues in their organization that they share and discuss information and ideas with frequently.

Tie strength is often examined in two ways. First, the *number of strong ties* and *number of weak ties* is examined. This approach mixes network size and strength together, which can create issues in determining whether creativity is due to network size or strength. Second, *network strength* is treated as a separate factor from network size, thus parsing the two effects out from one another. Overall, the relationship between network strength with creativity and innovation is positive (Baer et al., 2015). That is, when the strength of a person's network contacts increases their creative performance also increases too. Similarly, number of strong ties is also positively related to creative performance, whereas the number of weak ties is unrelated to creative performance.

The benefits from strong ties are due to a relationship built on trust and the frequency in which people communicate. Strong ties are more easily available and reliable (Coleman, 1990). You can more easily get in touch with them when you need their assistance. Strong ties are also those someone can more openly discuss ideas with in general without fear of them being stolen and also more radical and outlandish ideas that might be seen as high risk by others. Strong ties also play an important role when trying to implement ideas as close ties can provide "buy-in" to getting one's ideas implemented (Baer, 2012).

Although strong ties are beneficial for creativity, there are also drawbacks for these ties and instances where weak ties are beneficial. When people know each other over long durations and communicate frequently, the unique experiences and information between each person decreases. Strong ties then would only be able to provide redundant information over time. Given the importance of diverse ideas and perspectives for creativity, this redundant information would provide limited benefit for someone's creativity. In such cases, weak ties would be beneficial given they provide novel or nonredundant information. This novel information would especially be useful during early creative process stages like idea generation (Perry-Smith and Mannucci, 2017). Specifically, when generating ideas, weak network ties might be more useful for obtaining information and ideas. However, whether people are able to utilize this information for creativity depends on a person's personality. Specifically, research has shown that the personality trait openness to experience allows people to more effectively use the information provided (Baer, 2010).

Network Diversity

One underlying assumption for weak ties is they provide novel information. Although this might sometimes be the case, it is not always true. That is, weak ties could have the same functional and demographic backgrounds, which would mean the network

contact is homogenous to a given creator. Thus, it is important to consider and examine network diversity separate from network strength. Network diversity reflects differences among a person's network contacts with regard to functional, task-oriented differences (e.g., tenure, educational background) or demographic, relational-oriented differences (e.g., age, gender, race; Baer et al., 2015). A person's network diversity plays an important role as such diversity likely reflects unique experiences and information that can be of high importance for creativity and innovation. Indeed, prior research has demonstrated that network diversity is positively related to creative and innovative performance (Baer et al., 2015). This positive relationship, however, appears to be driven by functional differences within a person's network. That is, being able to obtain different ideas and perspectives is important. Demographic, or relational-oriented differences, is unrelated to creativity and innovation. Thus, the positive relationship between network diversity and creativity depends on the type of diversity within a person's network.

Brokerage

In addition to network size, strength, and diversity, a person's location within the whole network also plays an important role. Typically, the focus of one's location deals with whether a person bridges structural holes or serves in a *brokerage* position (Burt, 2004). Structural holes are gaps within the larger whole network. Thus, a person who fills these gaps and connects otherwise disconnected groups within a network has a potential advantage when it comes to creativity. These people are often referred to as "brokers" as they control the flow of information and other resources among two or more groups. Thus, these people have first access to nonredundant information, which provides them an advantage for using this information for their own work. Further, this first access provides someone autonomy to decide what they want to share and when they want to share it. Overall, brokerage is positively related to creativity and innovation (Baer et al., 2015).

Although there are many benefits to brokerage and filling structural holes, there are also potential disadvantages. First, if everyone within a network were trying to act like a broker, the benefits would disappear as the structural holes are now filled by multiple people. If everyone were filling a structure hole, that hole would no longer exist and no one would have first access to information or ideas. However, it is rare for all individuals to pursue brokerage positions as people's needs differ, influencing the types of personal networks they construct (Kadushin, 2012). Further, if a broker continuously obtained new information and did not share it, people would trust them less. This withholding of information, even by accident, would lead to both groups they span across unwilling to share more information. In the long run, this would harm the advantage of the broker's creative performance. Although brokerage is beneficial for creativity, it is important for brokers to understand the potential disadvantages of filling structural holes.

Network Closure

In addition to the above aspects, the extent other people within a person's network are connected together, or *network closure*, also impacts a person's creativity. Closed, or "dense," networks reflect instances when a person's network contacts are also strongly connected to each other. Given such strong ties are built on trust, it creates a larger social system with social norms where people would be less likely to exploit others (Coleman, 1990). Indeed, if someone were to exploit another person within the group, they would have to fix the wrongdoing, be punished, and/or be forced to leave the group. Because of these social norms, people would be more likely share critical information openly and coordinate seamlessly with each other, which might facilitate creative work.

Although there might be potential benefits of closed networks for creativity, the overall relationship between closure with creativity and innovation is negative (Baer et al., 2015). A dense personal network can restrict the flow of novel information, leading to ideas being low in creativity. Further, dense personal networks might result in people being more risk averse as they do not want to violate the social norms. This avoidance of risk taking will push people to conform more to those around them. This might seem contradictory to the benefits of network strength discussed above. However, network strength focuses on the ties to the focal person, whereas network closure deals with the relationships among the other ties within that focal person's network. Hypothetically, a person could have ten strong ties that are weak ties with one another (i.e., strong ties with a sparse closure), whereas another person might have ten strong ties that are also strongly connected to one another (i.e., strong ties with dense closure). These differences are important to consider for how network strength and closure relate to creativity and innovation.

Conclusion

Friendships and social networks not only play an important role in someone's life overall, but also for their creative and innovative work. This entry focused on five aspects of personal networks often studied in the social networks and creativity literature: network size, network strength, network diversity, brokerage, and network closure. Bigger personal networks typically help for creativity, but it is important to be mindful of networks that are too large as there are diminishing returns. Strong network ties typically help with creativity, but weak ties also play an important role as well. More diverse networks are important for obtaining differing perspectives and novel information, but this diversity should focus on functional rather than demographic differences. Brokers typically benefit from filling structural holes in larger social networks, but these benefits must be handled carefully. Finally, closed networks are

typically not as beneficial for creativity, but a strong collaborative group might hold benefits in other ways. This double-edge nature of social networks for creativity is important to consider when people use and gain assistance from their social networks.

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Functional Magnetic Resonance Imaging (fMRI) and the Neural Correlates of Artistic Creative Production

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Introduction

Research investigating the neuroscience of creativity has taken off in the last decade. Using neural techniques as a tool, scientists have investigated brain correlates of artistic planning and creative thought, traits of highly creative people, and reactions to artistic works. Using techniques like electroencephalography (EEG), positron emission tomography (PET), diffusor tension imaging (DTI), and transcranial direct current stimulation (tDCS), scientists have steadily begun to understand the neural activity supporting the creative process. The majority of research, however, has relied on magnetic resonance imaging (MRI) and functional magnetic resonance imaging (fMRI). fMRI utilizes blood oxygen level-dependent (BOLD) imaging because local consumption of oxyhemoglobin and conversion into deoxyhemoglobin represents a reliable, ferromagnetic marker for changes in neural activity. Measuring regional variations in BOLD signals thereby serves as a corollary of neural activity that allows researchers to map changes in brain activity associated with a wide range of cognitive, motor, or sensory tasks germane to creative processing in the brain. The strength of fMRI as a technique lies in the fact that it is non-ionizing and non-invasive, yet provides high spatial resolution.

Neuroscientists have largely taken two approaches to studying artistic creativity. One burgeoning approach studies the neural responses to works of art, sometimes referred to as the study of neuroaesthetics. The other approach examines neural responses involved in actively planning or creating art. This chapter focuses on the latter approach, surveying fMRI experiments that investigate the neural correlates of musical, visual, and verbal creativity, as well as nascent knowledge regarding kinesthetic creativity and the creativity of design and invention. While many expressive art forms exist, these fields discussed here represent performing art forms that have been the most widely investigated, to date, using neuroimaging techniques such as fMRI.

Musical Creativity: Improvisation

The majority of neuroimaging experiments on creativity thus far have focused on musical creativity rather than other art forms. This is likely due to the motor constraints placed on participants when lying in a fMRI scanner. Excessive movements by the participant cause artifact and blurry images, thus making it hard to study dance gestures, for example. With music, however, many researchers have found ways to circumvent these scanner-induced motor constraints. Participants lie supine in the scanner, and mentally improvise (Lu et al., 2017) or play custom-made nonferromagnetic keyboards (Bengtsson et al., 2007; Limb and Braun, 2008; de Manzano and Ullén, 2012a, 2012b; Pinho et al., 2014) or button boxes (Berkowitz and Ansari, 2008, 2010) held on their knees (Fig. 1).

By having participants play with their hands while holding other parts of their body immobile, investigators are able to acquire clear neural images while studying musical creativity. In addition to scanner-related adaptations, the mathematical structure of music makes it well suited for scientific manipulation, allowing for the design of well-controlled experiments intended to elucidate specific aspects of musical processing in the brain.

Adult Musicians and Improvisation

Music as an art form consists of many creative behaviors such as composing or expressive interpretation of musical phrases. Most experiments on musical creativity, however, have focused on improvisation, as it represents a “window into real-time creative processes” (pg. 1, [Loui, 2018](#)). Musical improvisation is a sophisticated process involving the rapid generation and production of novel melodic, harmonic, and rhythmic musical elements. An improvising musician must generate ideas and realize them on the instrument immediately, all while attempting to create aesthetically meaningful music within a particular musical context.

Early experiments had participants perform memorized or pre-learned tunes during the control task and improvise upon those tunes for the experimental task. For example, professional Classical pianists improvised based on a visually displayed melody in one condition, and then reproduced the previous improvisation from memory for the control condition. Improvisation resulted in activations in the right dorsolateral prefrontal cortex (DLPFC) and pre-supplementary motor area (preSMA), dorsal premotor cortex (PMd), and the left posterior superior temporal gyrus (STG) ([Bengtsson et al., 2007](#)). In an experiment studying professional jazz musicians, participants performed a pre-memorized jazz composition over a jazz track for the control task, and then improvised on that same tune for the experimental task ([Limb and Braun, 2008](#)). Improvisation resulted in a distinctive pattern of neural activation and deactivation—specifically a deactivation of the DLPFC and limbic areas, coupled with a simultaneous activation of the medial prefrontal cortex (MPFC), portions of the superior and middle temporal gyri (STG and MTG) involved in sensorimotor activity, and the anterior cingulate cortex (ACC). Neural activity in these two experiments thus showed different patterns of activity, likely due to differences in participants (classical vs. jazz musicians) as well as task demands (more free improvisation in [Limb and Braun, 2008](#)). Freestyle rap has also been investigated as an art form that lies at the intersection of music and spoken language ([Limb, 2010](#); [Liu et al., 2012](#)). Functional MRI of rappers revealed increased activity in left hemisphere language areas which is unsurprising given the genre, as well as a pattern of increased activity in the MPFC and preSMA and decreased activity in the DLPFC during freestyle rap improvisation ([Liu et al., 2012](#)).

Melodic vs. Rhythmic Improvisation

Other experiments have compared melodic versus rhythmic improvisation in order to identify differences in neural activity when the improvisation process is more constrained. Classically-trained college pianists improvised with pitch or rhythms while performing novel five-note tunes (experimental task) or pre-learned tunes (i.e., repeated pitches or ascending/descending scale for the control task). Both rhythmic and melodic improvisation activated the rostral cingulate zone (RCZ) of the ACC, the inferior frontal gyrus (IFG) and ventral premotor cortex, and the PMd, suggesting this network is generally involved in the invention of novel motor sequences. More specifically, melodic improvisation activated the right premotor cortex and left cerebellum and deactivated the right superior and medial frontal gyri, right angular gyrus (AG), and posterior cingulate ([Berkowitz and Ansari, 2008](#)). In another experiment comparing melodic versus rhythmic improvisation, researchers found that melodic improvisation activated more of the PMd, while rhythmic improvisation activated the preSMA, although there was some overlap of involved regions for both conditions ([de Manzano and Ullén, 2012a](#)). Moreover, the rhythmic improvisation condition resulted in more functional connectivity between



Figure 1 The experimental setup used in [Limb and Braun \(2008\)](#) as well as other fMRI experiments of musical creativity. A non-ferromagnetic keyboard (or button box) lies on the participant's lap while the head lies stationary in the magnetic bore of the fMRI machine. Participants see their hands and the keyboard via the mirror attached to the facemask used in the fMRI machine. When playing the piano, only the fingers move thereby allowing the participant to keep the head still enough to acquire high-quality images in the scanner.

the preSMA and cerebellum. Thus, it appears that the type of improvisation—focusing on pitch vs. rhythm—influences the brain networks involved. Although there was a degree of overlap in brain areas involved in these two types of improvisations (Beaty, 2015) and testing paradigms were slightly different, it appears that the pre-supplementary motor area was more active during rhythmic improvisation while the premotor cortex was active during melodic improvisation (see additional discussion in McPherson and Limb, 2018).

Collaborative Improvisation

While solo improvisation is quite common, jazz performances often involve collaborative improvisation between performers. In the single fMRI experiment on collaborative improvisation, jazz artists performed a common improvisational technique known as ‘trading fours,’ where jazz musicians exchange improvised materials in 4-measure units. The participant lay supine in the fMRI scanner while the experimenter responded musically to the participant from outside the scanner, taking turns improvising in a musical ‘conversation.’ For the control condition, the two individuals simply alternated pre-memorized 4 bar segments of a melody using their right hand rather than musically responding to each other. Given the language-like quality to these improvised musical exchanges, the experimental condition lead to activation of left hemisphere cortical areas and right hemisphere analogues generally associated with language (i.e., perisylvian language areas, Donnay et al., 2014). In contrast to a deactivation of the DLPFC seen in Limb and Braun (2008); this paradigm showed an activation of the DLPFC, perhaps due to the additional social component involved in collaborative playing and the increased need for working memory in order to respond effectively to musical partners.

Expertise and Improvisation

Not surprisingly, neural activation when improvising varies according to one’s expertise or training level in improvisation. For example, in one experiment comparing musicians to nonmusicians, musicians showed a deactivation of the right temporoparietal junction (rTPJ), thought to reflect an expertise-related focusing of goal-directed attention and filtering of irrelevant stimuli (Berkowitz and Ansari, 2010). Different genres of music also rely more heavily on improvisation than others. Jazz, for example, involves more improvisation than Classical music which may be why jazz musicians have enhanced perceptual sensitivity to unexpected musical events compared to Classical musicians (Przyssinda et al., 2017). Additionally, expert improvisers often perform differently from beginner improvisers. In an experiment testing jazz and classical musicians who had spent varying amounts of time practicing improvisation across the lifetime, more highly trained improvisers had lower activity in frontal parietal association areas and greater functional connectivity between prefrontal, premotor, and motor regions of the frontal lobe (Pinho et al., 2014). Because these effects were specific to improvisation experience and independent of piano experience or age, this suggests that improvisation taps into an independent neural network from the network built by practicing an instrument. The ability to improvise utilizes a different network than the one that undergirds the ability to play the piano. This makes sense considering that creativity in improvisation is not simply a matter of freely selecting individual notes or sounds; expert improvisers rely on long-term knowledge of musical patterns and musical structures that can then be called upon rapidly, using simpler structures to build more complex performances (Pressing, 2001). Higher functional connectivity in expert improvisers may reflect that their brains are reorganized to automate these processes, making them more efficient at tapping into pre-learned motor patterns and strategies (Beaty, 2015; Pinho et al., 2016).

The Impact of Context on Improvisation: Emotion

While long-term training can thus lead to differences in neural activation or functional activity while improvising, short-term effects exist as well. Context shapes the neural networks involved in improvisation. For example, several studies have investigated the impact of emotion on improvisation. In one fMRI experiment, professional jazz pianists were shown photographs of an actress depicting a positive, negative or ambiguous emotion. The participants then performed improvisations that they felt expressed the emotions in the cue cards. It was found that the emotional intent modulated brain activity. For example, ambiguous and negative improvisations demonstrated heightened activity in the right insula, ACC, right parietal cortex, bilateral middle temporal lobes, and bilateral prefrontal cortex compared to positive improvisations. Positive emotion improvisations showed more cerebellar activity as well as more pronounced deactivation of the DLPFC compared to negative improvisations. Musical creativity is thus context-dependent; emotional state can influence the neural mechanisms underlying improvisation (Mcpherson et al., 2016).

Other experiments have likewise shown that neural networks involved for improvisation are highly task-dependent. In an experiment where trained musicians had to either improvise with a given pitch set (tonal or atonal pitch sets) vs. free improvise with a certain emotional content (happy/fearful), it was found that the pitch set conditions saw an increase in activity in the DLPFC as well as higher functional connectivity between the premotor and parietal areas. By contrast, for the emotional conditions, there was a deactivation of the DLPFC and greater functional connectivity with the default mode network. The authors believed that these two networks formed two different pathways by which creativity could be completed; the pitch set condition required memory and a more explicit approach and thus the DLPFC was more active to synthesize sensory and goal-related information. By contrast, the emotional condition might have used more of an implicit strategy that favored spontaneity and flexibility, thereby relying on the default mode network which automates processes (Pinho et al., 2016). These experiments illustrate that constraints upon the improvisation shape the neural network supporting the creative process.

Summary: Neural Networks Involved with Musical Improvisation

Researchers have used different paradigms, equipment, and participant groups to investigate musical improvisation which may explain the disparities in results seen across studies (Dietrich and Kanso, 2010; Bashwiner, 2018; McPherson and Limb, 2018). Nevertheless, neuroimaging experiments generally show that the frontal temporal, parietal, premotor and secondary auditory areas are regions of interest. Specifically, structures like the MPFC and cingulate cortex, the DLPFC, inferior frontal cortices (e.g., inferior frontal gyrus), dorsal premotor areas (for motor planning and sequencing), and presupplementary and supplementary motor areas are associated with improvisation (Pinho et al., 2016; Bashwiner, 2018; McPherson and Limb, 2018).¹ Frontal activity is particularly interesting as improvisation often leads to increased activity in the MPFC with decreases in DPFLC activity (Loui, 2018). Moreover, researchers have noted that prefrontal activity varies from study to study depending upon the expertise level of participants, the cognitive demand of the improvisation task, as well as whether the improvisation is loosely or tightly constrained.

These brain structures active during improvisation belong to several functional networks such as the default mode and executive networks (Beaty, 2015; Loui, 2018). The executive network (which includes mesial prefrontal regions like the MPFC and cingulate cortex) is often active during tasks that require cognitive control, while the default mode network (which includes cortical midline and posterior parietal areas like the DLPFC, inferior parietal regions, parahippocampal gyrus, hippocampus) is associated with defocused mind-wandering, internally-directed thought, and a state of 'flow.' While these two networks may seem like opposing forces, the fact that they are concurrently active during improvisation suggests that rather than being opposites they simply show "differential involvement as a function of task demands" (pg. 115, Beaty, 2015). Recent brain connectivity research has shown that the salience network (comprised of the bilateral insula and ACC) may serve as a conduit between the default and executive networks, identifying ideas generated during improvisation by the default network and forwarding this information to executive systems for higher order processing such as evaluation or revision (see discussion in Beaty et al., 2018). Indeed, highly creative people (as measured by their divergent thinking abilities) show dense functional connections between the default, executive, and salience brain networks (Beaty et al., 2018). The complexity of regions involved in improvisation mirrors the complexity of improvisation itself. An improviser generates new ideas, but also selects and evaluates them quickly, utilizing both the default network and the executive network (Loui, 2013). From an artistic standpoint, musicians simultaneously control the creative process by selecting musical ideas and implementing them, while at the same time "letting go" in order to allow the music to unfold holistically and organically. Thus, improvisation requires a degree of automation, and yet is also generative. Neural imaging experiments illustrate this duality, with musical improvisation tapping into large-scale brain networks that support cognitive control and focused attention concurrently with spontaneity and creativity.

Visual Creativity

Exploration is underway to examine whether neural networks underlying creativity are domain general or idiomatic to a particular artistic genre (de Manzano and Ullén, 2012b; Beaty, 2015). As mentioned previously, the majority of experiments on creativity have focused on musical creativity, however, a small subset of studies have explored neural activity associated with the visual arts. In a case study of an artist sketching a portrait, decreased activity in the fusiform gyrus was found when the artist was copying drawings of faces (Solso, 2001).

Group experiments have investigated the neural correlates underlying visual creativity tasks and artistic planning. Some researchers have found an association between the right parietal lobe and visuospatial processing (Gansler et al., 2011). Other researchers have found that visually creative tasks lead to increased activity in left middle and inferior frontal lobes and decreases in activity in the right middle frontal lobe and left inferior parietal lobe (Huang et al., 2013). In one study of visuospatial creativity, architects and architecture students either mentally rotated shapes into a larger recognizable shape (the control task, a convergent thinking task) or performed a right-hemisphere task where they arranged three distinct shapes into a creative composite image (the experimental task, a divergent thinking task). Both tasks activated the parietal cortex bilaterally and motor regions known to be involved in visuospatial rotation of objects. However, the creative task in this particular experiment led to higher activation in left hemisphere regions like the posterior parietal cortex, premotor cortex, DLPFC, and MPFC (Aziz-Zadeh et al., 2013), similar structures that have been linked to musical improvisation.

In another experiment, participants played Pictionary™ using an MR-safe tablet. For the experimental task, they drew certain words (ex., 'snore', 'graduate') while for the control task they made a drawing for the control word ('zigzag'). This paradigm therefore allowed an investigation of figural creativity without explicitly instructing participants to be 'creative.' The drawing condition led to increased engagement of the cerebellum, thalamus, left parietal cortex, right superior frontal, left prefrontal and paracingulate regions (Saggar et al., 2015). Thus, compared to musical improvisation, some overlap exists for the neural correlates underlying this visual creativity. In particular, decreased activity in the ACC/DLPFC was associated with more highly creative drawings, similar to the neural activity in the jazz experts tested in Limb and Braun (2008). Additionally, visual creativity led to increased activity in the cerebellum, mirroring the results from Pinho et al. (2014) studying musical improvisation.

¹In one experiment comparing improvisation to pseudorandom response generation, it was found that similar brain structures were involved for these two generative tasks; real-life creative behaviors like musical improvisation are controlled by the same cortical network that allows other forms of free generative action. Further research is necessary to explore what separates "creative from non-creative cognition" (pg. 779, de Manzano and Ullén, 2012b).

This brief survey shows that disparities are seen across studies due to the differences in task demands, paradigms, and participants (for a more detailed review, see the meta-analysis in [Pidgeon et al., 2016](#)). More research is necessary but it has been posited that different neural systems are used at different points in the artistic process. [Heilman and Acosta \(2013\)](#) theorize that during the innovative stage when a creative artist is planning a picture, the artist may recruit global attentional systems of the right hemisphere. However, later during the production stage which necessitates a focus on details, the artist may rely more heavily on the left hemisphere's focal attentional systems, and/or intermittently switch between these systems ([Heilman and Acosta, 2013](#)). One functional connectivity experiment has begun to delve into the neural substrates underlying visual composition planning. In an experiment investigating visual artwork planning, professional artists and a matched group of control participants completed three tasks while scanned in a fMRI machine ([De Pisapia et al., 2016](#)). Participants performed: 1) a control block involving mind wandering and defocused thinking, 2) a control block where they had to visualize the letters of the alphabet from A to Z and imagine drawing them thereby performing a repeated visual imagery task, and 3) an experimental block where participants were given 8 minutes to create and visualize a landscape (either geographical or metaphorical). Afterwards, artists immediately sketched out their planned artwork (see [Fig. 2](#)). Functional connectivity analysis revealed that the creativity task resulted in higher connectivity between the executive network (EN) and the default mode network (DMN), with professional artists showing this difference more strongly (particularly the connection between the precuneus of the DMN and the cingulate cortex, premotor cortex, parahippocampal cortex/fusiform gyrus, DLPFC and associative visual cortex). Obviously further research is necessary, but planning a visual art composition appears to activate similar neural networks to those involved in musical improvisation. As mentioned previously, creativity is a balance between idea generation and evaluation, convergent thinking and divergent thinking, and therefore brain activity shows an interplay between the executive network and the default mode network. Comparing these visual art experiments to research in the field of music illustrates that creativity has certain neural correlates that are domain specific (ex., the visuospatial regions activated for visual creativity tasks vs. the secondary auditory areas activated in music improvisation experiments) while other brain networks may underlie creativity across artistic domains, supporting creativity in a domain general manner.

Verbal Creativity

One form of ubiquitous 'everyday creativity' is the fact that humans converse with one another without a pre-written script. Recent fMRI neuroimaging experiments have begun to look at more formal forms of verbal creativity such as written humor ([Amir and Biederman, 2016](#)), creative story generation ([Howard-Jones et al., 2005](#); [Shah et al., 2013](#)), and poetry composition ([Liu et al., 2015](#)). When generating either a mundane (control task) or humorous (experimental task) caption to a presented *New Yorker* cartoon, expertise effects were found in a participant group of professional and amateur 'improv' comedians. Greater comedic experience was associated with decreased activation in the striatum and MPFC, but heightened activation in temporal association regions ([Amir and Biederman, 2016](#)). In contrast, amateur improv artists showed increased activation of the MPFC ([Amir and Biederman, 2016](#)). Expert comedians, in short, may be relying more on the spontaneous flow in their creative process as has been seen in musical experts as well ([Limb and Braun, 2008](#)).

Researchers have begun to look at neural activity during subprocesses of the creative writing process, from brainstorming (planning a story) to creative writing (actually writing a continuation of a given literary text out by hand, see [Fig. 3](#)) ([Shah et al., 2013](#)).

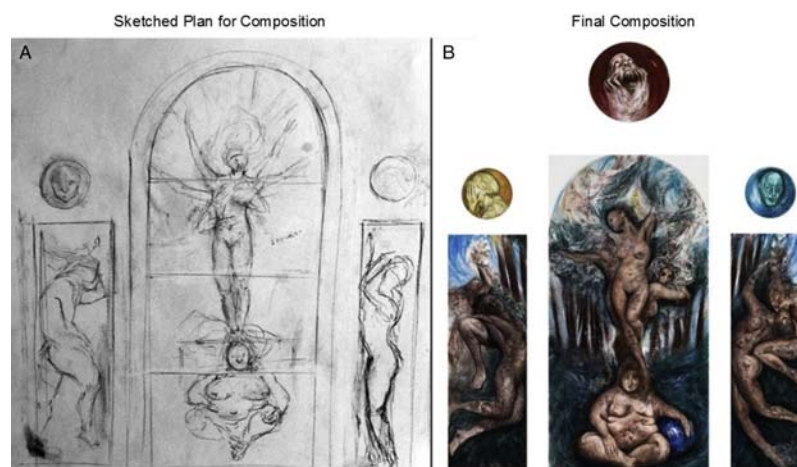


Figure 2 Example of artwork generated during visual planning experiment, figure adapted from [De Pisapia et al. \(2016\)](#). Left panel (A) is a sample initial sketch done by a participant directly following the fMRI scanning session while right panel (B) is the final artwork, completed in the weeks following the experiment. A selection of the artistic compositions generated from this experiment were displayed in a museum exhibition entitled "In resonance: snapshots of creativity in the brain" (*In risonanza: istantanee di creatività nel cervello*, 2013–2014) at the Museum of Contemporary and Modern Art of Rovereto and Trento (MART) in Italy.

Brainstorming activated language processing areas such as the bilateral inferior frontal gyrus (IFG) and left temporal areas, hierarchical organization in the prefrontal cortex, and cognitive decision processes in the dorsal ACC. Compared to simply copying text (the control condition), creative story generation lead to activation in areas associated with memory retrieval, semantic integration, free association and spontaneous cognition, located in a left fronto-temporal network including the left IFG and left temporal pole. In an experiment where participants created stories from a given set of words, creativity story generation was similarly associated with an increase in prefrontal areas like the bilateral medial frontal gyri and left ACC (Howard-Jones et al., 2005).

While many of the experiments on creativity have focused on the generative phase where ideas are produced rapidly, relatively little attention has been paid to the revision process, where ideas are modified and adapted. In an experiment on poetry composition, generating a new poem lead to a dissociated pattern of increased activity in the MPFC and decreased activity in the DLPFC, similar to what has been found in spontaneous music improvisation (Limb and Braun, 2008). During the revision task where participants edited the aesthetic content of their poems, however, the neural activity was the opposite of the generation phase, showing activation of the DLPFC and intraparietal sulcus. Thus, this experiment illustrates that different parts of the creative process lead to reciprocal changes in prefrontal and parietal areas. While there are still relatively few experiments studying the creative writing process, the existing neuroimaging experiments excel at subdividing the creative process into components to look at neural activity with each associated stage.

Kinesthetic Creativity and Design Creativity

This chapter has primarily focused on fMRI experiments of musical, visual, and verbal creativity. Researchers, however, have begun to branch into investigations of kinesthetic creativity. Given the motion constraints of the fMRI scanner, physical gestures are naturally quite difficult to study. For this reason, rather than investigating neural networks associated with the actual performance or execution of physical gestures, experiments have instead focused on the neural activity underlying motor planning rather than motor production. For example, in a study of trained ballroom dancers, scientists used a novel paradigm where the dance participants used bimanual contact with an experimenter standing by the fMRI magnet bore and the two of them would alternate acting as the leader or follower in joint “improvised” dance movements. As with musical improvisation, dance improvisation (in comparison to fixed movement patterns) revealed the importance of premotor and working memory areas such as the PMd, SMA, IFG, DLPFC, STG, and putamen (Chauvigné et al., 2018).² In an experiment where participants watched videos of a soccer scene and then had to imagine a creative or obvious move as a continuing play, soccer-specific creativity tasks modulated activation levels in visual and sensorimotor areas (Fink et al., 2018). Thus, neuroimaging investigations of dance, sports, or other motor creativity remain relatively scarce but are beginning to investigate motor planning and creative motor imagery.

Another burgeoning field is the neuroscience of design creativity which allows the creation and development of artifacts, processes, symbolic systems, scripts, laws, behavior and so forth to solve complex problems in the modern world (for a detailed review, see Lazar, 2018). While a more comprehensive summary lies beyond the scope of this chapter, recent fMRI experiments have looked at the neural activity associated with designing book covers (Ellamil et al., 2012), arranging furniture within a constrained space (Gilbert et al., 2010), or designing a new tool such as a pen (Kowatari et al., 2009). Currently, existing experiments



Figure 3 Experimental setup used to investigate neural correlates of a creative writing task, figure adapted from Shah et al. (2013). Participants used an MR-safe writing desk while lying prone in the fMRI scanner. An experimenter stood next to the scanner to switch out the sheets of paper as the participants completed the task of writing out the continuation of a story by hand. Participants could see their hands and written text using the double-mirror attached to the head coil.

²For a review of the neural correlates underlying dance perception, dance expertise, and dance gestures, see reviews in Karpati et al. (2017) (Cross and Ticini, 2012; Karpati et al., 2015).

show that design cognition utilizes brain networks that only partially overlap with regions associated with musical, verbal, and visuospatial creativity although these studies use a wide variety of tasks and future experiments are needed (Lazar, 2018).

Conclusions and Future Directions

This chapter has briefly surveyed neuroimaging experiments investigating artistic production and planning. These experiments have revealed neural correlates that are idiomatic to particular artistic domains as well as substrates that are domain general. The creativity underlying artistic production generally consists of idea generation, evaluation, and automation of overlearned processes or motor movements, therefore striking a balance between involvement of both the default mode network and the executive network. Naturally, movement constraints exist with using a fMRI scanner and lying motionless and supine in the machine is not the most ecologically-valid or ideal setting for artistic inspiration. Nevertheless, research in the last decade has made strides towards understanding the neural activity associated with artistic production, even if fMRI experiments utilize a wide variety of paradigms, tasks, and populations. Even for musical creativity, the most-studied artistic field, many unanswered future questions remain. As discussed in this chapter, creativity is a multifactorial process (Dietrich, 2004). Future experiments will have to further explore the sub-processes underlying creative production (such as with experiments examining the generative phase vs. the revision phase) and continue to look at creativity across different art forms.

Moreover, while experiments examining the effects of expertise exist, more research is necessary to compare non-experts to amateur artists to expert artists. On a related note, relatively little is known about whether creativity changes across the lifetime. Are there age-related differences in creativity? Finally, are variations in artistic creativity due to innate differences or extensive training? What are the exact brain changes that occur due to creativity-induced neural plasticity? Using longitudinal studies of creative vs. non-creative interventions, science may begin to gain a deeper understanding of how creativity shapes the brain. With that knowledge, we may then be able to translate research into real-world interventions to increase creativity in the general population. In a time when the arts and the importance of creativity can be politically and educationally undervalued, scientific interdisciplinary work as described here is more necessary than ever. Despite the vital role played by creativity in human achievement throughout history, our understanding of how creativity unfolds in the brain remains incomplete. While it is difficult to study creativity and improvisation (by nature novel and spontaneous) using the scientific method (by nature systematic and rigorously-controlled), it is an enterprise of critical importance. Efforts to increase and maintain creative abilities over the lifetime and in a variety of fields is crucial, as creativity is considered an 'intangible asset' for future success (as discussed in Fauth et al., 2009), whether in everyday activities or in developing society's cherished works of art.

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G

Geeks

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Glossary

Bronies Participants in fan communities who share their enjoyment of the *My Little Pony* franchise. They are often identified in mainstream discourse for the non-normative demographic characteristics of being teenaged and young adult males.

Cosplay Products and performances created by members of fandom communities that emerge from the tailoring of fantastic costumes as works of art.

Fanart A variety of art practices, inclusive of drawing, painting, tailoring, sculpture, and stop-motion animation, among others, that expresses identification with a fandom community.

Fandom A subcultural community that exists to express a shared enthusiasm for a topic. These topics can vary in extremes, in some cases being extremely abstruse, rarified, and sophisticated, and in others being broad, open, and easily apprehensible.

Fanfic A variety of literacy practices, inclusive of producing short stories, poetry, lyrics, and fantasy worlds, among others, that expresses identification with a fandom community.

Furries Participants in subcultural communities who develop and enact identities based on anthropomorphic animal characters.

Incel Participants in androcentric subcultural communities who emphasize their 'involuntary celibate' status. They are often identified in mainstream discourse for the potentially harmful and misogynistic character of their ideologies.

Therians Participants in subcultural communities who feel, for personal or religious reasons, that they share in the spiritual essence of an earthly, non-human animal.

Introduction

Who are geeks? This question might immediately invoke a response in reflex: The image of a person with glasses, nasality, educational ambition, perhaps poor personal hygiene and very poor social skills. The reason for this is not complicated. In their most stereotyped form, geeks are very familiar to individuals from a variety of cultures, though displaying mild local variation in connotation and nomenclature. They are, for example, referred to as "nerds" or "dweebs" in different communities around the United States. Similarly, they are sometimes referred to as "boffins" or "keenos" in England, "otaku" in Japan, and "strebers" in Germany.

Given the wide availability of the stereotype of the geek, it is not uncommon to see representations of them in popular media. Whether it be in recent television productions (such as the *Big Bang Theory*), or in movies, new and nostalgic (*Napoleon Dynamite* and *Revenge of the Nerds*), or even in websites claiming to devote themselves to all things geek (www.geek.com). In this way, the concept of the geek has proven to be an enduring staple in the modern consciousness.

And yet, the idea of the geek has not been a static fixture. It has undergone an extraordinary evolution to the present era (see Engelhart, 2012 for an account). As the concept has matured, it has expanded to include its own unique conceptualizations of culture and community, developing into a rich tapestry of related ideological camps – or "imagined communities" – of like-minded individuals who identify as a geek and share similar values.

Ethnographic investigations of various geek culture communities have proposed a number of theories concerning the importance of participation in this historically stigmatized subculture (Tocci, 2009), often attending to the rationale for participation in these communities in spite of the attached stigma. This has often entailed exploring individuals' deep feelings of loyalty to, and belonging with, these communities in spite of their problematic nature. On the whole, reasons for participating in geek communities may be summarized as both an identification with the "geek ethos" – a set of values common to all geek cultures – and a desire to create an "ideal geek community" (Piña, 2018).

Therein, embedded as it is in the geek ethos, is a clear articulation of both the aspirational drive for creativity and the need for consistent engagement in creative activities. This is made plain in the writings of self-described geeks like those of Lars Konzack, who argued that "Geeks are incredibly creative minded. They like to contribute artistically to the geek culture, not just consuming it. The geeks don't just read comics, but they make their own drawings as well. The geeks are not just playing games, but try to make game content too" (2006, pp. 6–7).

Although creativity appears to be an ideal equally held in all aspects of the geek culture, this is not to say that it is equally instantiated in every sector of the culture or in every community. Creative behavior may look extraordinarily different, for example, between a group of older roleplaying gamers who meet on weekends and a group of younger schoolmates who share a love of computer programming and meet primarily through virtual media. Extant research has provided two primary vantages for understanding underlying relationships which may account for variation in creative expression, being continua based on: (1) age-related psychosocial development, and (2) avocational engagement in informal participatory cultures.

In the coming sections, these areas will be explored by attending to research which has highlighted the experiences which shape the creativity of younger adolescent geeks and the creative contexts of older geeks, as well as creativity as expressed relative to participation in fandoms and creative behaviors occurring as a consequence of participation in fan communities.

The Creativity of Adolescent Geeks

It is in approaching adolescence that the geek identity first seems to matter deeply for young people. This is likely the result of a host of psychosocial developmental changes that take place in quick succession, as peer group approval and the role of popularity become increasingly salient to young teens. In consequence, while the geek identity may bear some latent ideological stigma from cultural presentations of the stereotype among children, it is in adolescence where this burden is thought to be most acutely felt: Adolescent geeks are, to varying degrees based on their local community and educational context, subject to ostracism and harassment from their peers.

As such, the general presentation of peer communities of young geeks has a tendency to be relatively small, closely-knit, and semipermeable, with a supportive and nonconformist character. This is perhaps most lucidly exemplified in ethnographic works like that of Bucholtz (1999), wherein the author described a local "Bay City" high school group of young geeks, the "anti-club" entitled Random Reigns Supreme (1999, pp. 212–213). This group was small, consisting of only four core members and two peripheral participants, but despite its size, demonstrated a nimety of what the author described as "positive identity practices" – that is to say, activities and behaviors which built group identity by upholding a common set of "subversive" values, including an emphasis on the importance of "randomness" (replacing the traditional effort to emphasize more popular topics, like sports and clothing), as well as frequent displays of wit, knowledgeability, and intelligence (1999, pp. 214–218).

From examples like this, it is apparent that both the organization and composition of adolescent geek communities appears to have some influence on the creative expressions of participants. Piña (2018) found that contextually-embedded social characteristics of public schools, most especially peer support and attitudes toward academic performance, predicted associative differences in the "identity transition status" of young geeks, which, in turn, framed noteworthy patterns of variation in the domains of creative engagement, both in the quantity of creative efforts in those domains and in the perceived quality, or social recognition, of those creative efforts. Among students who had "embraced" their geek identity, for example, there were statistically significant comparative increases in the quantity and quality of scientific and mathematical creativity, whereas among students who had "normalized" their geek identity, there were notable differences in the quantity, but not quality, of artistic creativity (2018, p. 109).

These insights highlight the paramount importance of continuing to advance a diverse view of the experiences of adolescent geeks, and, additionally, of engaging young people in transformative dialogue about inclusiveness in geek culture venues. Given the growing awareness of the manner in which the stigma of being a geek is compounded by social factors affecting young women, cultural minorities, and especially culturally-diverse young women (Herrera, 2017), an unambiguous conclusion is that gate-keeping activities – actions designed to keep 'unwanted' or 'unworthy' individuals out of the geek culture (as in Reagle, 2015) – are harmful not only due to their effect of socially isolating vulnerable groups of adolescent geeks, but also in that they create conditions whereby the creative benefit of engagement with geek culture can be suppressed (Piña, 2018), and, indeed, where otherwise extraordinary conditions for burgeoning creativity may be exhausted by the thoughtless actions of a callous few.

The Creativity of Adult Geeks

Coming to describe oneself as a geek in adulthood can be seen as one of many developmental outcomes resultant from structuring one's identity throughout adolescence against the changing social realities of participation in the geek culture (see Pegg, 2012 for an autobiographical account). Young adult geeks in America – like many groups of young adults in the Western culture – tend to discover that, as they advance through adolescence, their peer culture is a product more of their own choice, and also that their ability to harness resources allows for some discretion in how they engage with geek culture activities. For these reasons, there is a context of recent access to relative cultural freedom that undergirds nascent understanding of the creative potential of adult geeks.

As such, much of the work comprising field of Geek Studies has framed contemporaneous notion of the adult geek to primarily one of three conceptual positions articulating these newly-conferred freedoms, these being positions on (1) the narrative of struggle against a historical stigma giving rise to an increasingly popular representation of the geek, (2) the value of the modern role of the geek identity as a facilitator of innovation, especially as it relates to technology and digital media, and (3) the troubling representation of the geek as a transgressive figure – a cultural misfit who engages in bizarre behaviors, often spurred on through connection to online forums.

Addressing the first of these three perspectives are works like those of Kendall (2011), and Claassen (2015) which concerned themselves with the representational evolution of the geek, both as applied to the popular culture, and as it illuminated the view that geeks have held of themselves in the midst of changing attitudes. Compellingly, both of these authors focused on a different artifact of the evolution of the geek culture as a means of interpreting the significance of the changing popular opinion of the geek: Kendall (2011) unpacked recent geek-centric media representations and the rise of “nerdcore” music while Claassen (2015) analyzed the effects of a rapidly-changing geek culture through the examples of movies, including *Ready Player One* and *Dodgeball*.

These works helped shape a central theme of the perspective: That, as Claassen (2015) posited, geeks now occupy an ambiguous and paradoxical position within the popular imagination, being somehow both “misfit” and “cool” simultaneously. The consequences of this condition are not yet widely understood, and there seems to be no real agreement in the significance of the transition. Kendall (2011), followed a continual argument tracing the enduring association of the geek identity with whiteness and hegemonic masculinity – in essence, casting a cautionary and critical light on the exclusionary cultural underpinnings of the geek stereotype, no matter the level of popular acceptance. On the other end of the spectrum, Claassen (2015) has advocated the more benign notion that the geek is becoming just another variety of popular, well-known identity.

A distinct element of the geek culture which has aided in its ascent in the popular imagination – and one which more immediately relates to the topic of creativity – is found in a second Geek Studies perspective that stresses the singular, and ever-growing, importance of technological and scientific development. Here, there are depictions of the geek as a “genius” (as in Tocci, 2009) who has the potential to contribute to human mastery of the world through the creation of scientific, as well as technological, and, to an odd level of specificity, computational innovations. Unlike the ambivalent view given earlier of the geek as a regular, albeit relatively niche, identity to be embraced and/or mocked, in this perspective, geeks are cast as the object of respect and admiration due to their ability to harness technical “wizardry.”

A salient observation of this strand of research is that, even though role of the geek is praised as a key to innovation, there remains a gap in knowledge of the mechanism by which participation in geek culture can be determined to actually facilitate such innovation – and, by proxy, creativity in the broader sense. This is to say that there is yet no strong theory or even competing theories of ‘geek creativity’, per se, but not to imply that no research on the topic exists, nor that there are no initial insights from which to work: Utilizing survey data, McCain et al. (2015), for instance, accumulated evidence to support the insight that individuals who more strongly identify as geeks concurrently demonstrate statistically significant increases in creative engagement, creative ideation, and positivity toward the concept of creativity (2015, pg. 27).

However, as perspectives of the innovative nature of geeks are refined, so too must society come to terms with the darker and stranger interpretations of geek culture. As creativity and nonconformity are deeply entwined (Runco, 2014), there is a natural basis for understanding consequent social implications: To the degree that geeks can be innovative, so too can they express themselves through oddball activities. And, in fact, there is an abundance of evidence for this tendency. From furies to therians, to bronzies, the support and acceptance for “misfits” availed of in the geek culture (as in Tocci, 2009) has provided a forum and structure to adult communities with personal, religious, and sexual expressions that may otherwise be considered transgressive in the dominant culture. And, while undeniably eccentric, these groups appear to be, more or less, harmless instantiations of the playfully transgressive character of passionate participation.

This “misfit” aspect of the geek culture can genuinely become a cause for concern, though, when it intersects with the advancement of harmful ideals and behaviors. Here, by way of pluperfect example, it is the community of involuntary celibates – “incels” – which has undoubtedly garnered the greatest attention. To date, participation in the incel community has been linked to acts of terroristic violence, the perpetuation of virulent racism and misogyny, and the promotion of suicidal ideation among its members. Given the seriousness of these actions, the question that consequently arises with regard to incels – and, more broadly, to all participants of the hate-fueled, anti-feminist “manosphere” (Ging, 2017) – is a fundamental one: What can be done? If incel communities reflect the deepest pain and resentment of the geek community, and that pain seems undiminished (and, in fact, exacerbated) by social advancements made by the geek culture at large, what future steps can be taken to ameliorate this very real and dangerous problem?

There are, as yet, no fully satisfactory answers to these questions. At best, current understanding illuminates that the hateful behavior of these individuals is most likely to be driven by persistent feelings of loneliness. MacDonald (2016), targeted this loneliness, as well as concomitant depression, as the root cause of negativity in the incel community, and argued that a combination of cognitive-behavioral therapy and social skills training may be most effective solution. It is perhaps possible, then, that one means of large-scale intervention might be to make use of existing social structures in geek communities, such as culturally intermediate “alpha geeks” (as in Piña, 2018), to advocate for such therapies, by, at a minimum, raising awareness of the importance of mental health in geek communities and receiving education on the topic. Through these means, informed geek spaces will also better express the qualities of creative climates, especially in advancing open-mindedness and support, as well as offering important resources to community members. It is left to future researchers, however, to determine the organization of such a program.

The Creativity of Fan Communities

An alternate, and complementary, approach to understanding the role of the geek culture as a support system for eliciting creative behavior can be found in examinations of interactional modes of topic-focused geek communities or “fandoms” (as in McCain et al., 2015). Here, unlike in the case for the psychosocial perspective in the Geek Studies, a widely applicable model for creative facilitation has been propounded: That engaged participation with an area of interest in the geek culture can elicit strong enthusiasm for an avocation, which in turn fuels the desire for creative expression. However, this unified perspective of a mechanism for creative participation does not imply that creative products and behaviors will be even remotely similar, and for a simple reason: Areas of geek interest can vary wildly encompassing, among other things, deep interaction with fantasy worlds and sci-fi settings, interest in computer technology and engineering, and other, obscure interests, all of which draw from different creative domains.

Due to the extraordinary diversity in fandoms, it is unlikely that a complete, exhaustive accounting of the creativity of all fandoms can ever be given. Rather, it may be of greater value to instead compare, at the broadest level, how these fan communities have historically engaged with their interests in two broad areas: Through the development of (1) fanart and through the development of (2) fanfic.

Creative efforts of the first type, those characterized by making use of geeky topics serving as inspiration for “fanart” creations (as in Manifold, 2013), have tended to demonstrate the ability to invoke emotional resonance in enthusiasts, to arouse curiosity and the pursuit of meaningful challenges, and to provide a basis for supportive participation in communities who share a recognition for the importance of each participants efforts. An excellent example of these elements converging exists in communities supporting the fanart of “costume play”, or “cosplay”, which is an artmaking practice involving the production of elaborate costumes representing fictional characters, most often drawn from depictions in popular video games, television shows, and manga. Through cosplay, essential artistic skills are practiced and affective attachments to the material are explored in a fluid manner within whole communities.

For these reasons, participation in cosplay communities, and, by extension, fanart communities categorically, has been promoted as a necessary supplement to formal education in the visual arts, with informal fan communities occupying a role as both avocational playgrounds and continued vocational training. This cooperative interaction among personal, playful, professional, and purposeful work in fan communities is especially significant in fanart communities working with digital media and programming – perhaps blurring a line between geek culture and the “maker movement” – whereby fans modify, or “mod”, digital assets, such video games and user interfaces, in an innovative process that Kücklich (2005) summarily dubbed “playbour.” Here, it is valuable to point out that many avenues of future research yet exist in the study of fanart and its many variant instantiation, as this type of participatory creativity appears to have expanded to encompass practices that deviate from a simplistic understanding of artistry as it may have been understood in previous eras.

But it is not through fanart alone that geeks may partake in simultaneous productivity and affective or semiotic participation. Fan communities also display a propensity to produce unofficial written works and performances as fictional extensions of their source material, a practice referred to as “fan fiction” or “fanfic” writing. Fanfic has a rich history and a perennially notorious reputation, being both the birthplace of new popular media, such as the *Fifty Shades of Grey* book series, as well as the origin of a not inconsiderable amount of homoerotic and fetishistic “slash” fiction. As with fanart communities, the creativity of fanfic communities is thought to stem from the highly collaborative nature of the culture. Fanfic, too, has many variant instantiations, with written works being translated as stage productions, movie script “remixes”, and fan poetry.

Ultimately, though, a key difference in the creative expressions of fanfic and fanart communities can be determined by considering the relative ease with which fanfic authors may undertake to innovate the systems and settings presented in written texts as a medium in themselves for creative discovery. In this sort of work, rather than deriving a new narrative, character, object, or event from fiction, an entire imaginary world is itself taken as the subject – a creative act known as “world-building” (see Wolf, 2014 for an in-depth discussion). Working from the world as a starting point, world-building can encapsulate generative activities like the formulation of constructed languages and the proposal of differing reality systems. This has been one of the hallmarks of creative individuals.

In geek communities, world-building is a traditional practice of certain writing groups and a tool of “game masters” who lead table top role playing gaming groups. Increasingly, too, world-building is manifest as transmedia storytelling and in the wider promulgation of participatory narratives. “Alternate reality games”, for example, offer an opportunity for geeks to play in a constructed world that pervades from the digital realm into the physical, fostering a special, strongly immersive experience within the interactive structure of the overall narrative.

There is a growing understanding that these storytelling experiences may be useful as a new type of creative learning environment, which in themselves may provide an otherwise unexplored vantage by which shed light on the evolutionary cycles within creative development (Velikovsky, 2014). This suggests that future investigations concerning of the creativity of fanfic communities may well be served by accounting for the manner by which these new media have influenced participants to create novel elaborations, not of single objects or ideas, but of complex systems and complete imaginary worlds.

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Genius and Greatness[☆]

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Introduction

Consider the following historical personalities: Napoleon Bonaparte, Abraham Lincoln, Isaac Newton, Marie Curie, Leo Tolstoy, Leonardo da Vinci, and Ludwig van Beethoven. What do they have in common that sets them apart from the rest of us? Several answers are possible, but two perhaps stand out. First, all can be considered geniuses of some kind, whether military, political, scientific, or artistic. Second, all can be said to display greatness in their chosen domain of achievement. Thus, Napoleon was a great general, Lincoln a great president, Newton a great scientist, and so forth. In these examples, genius and greatness appear to go together. Yet do they always have to correspond? Can genius exist without greatness or greatness without genius? It is the purpose of this entry to examine the conceptual connection between these two constructs. Discussion begins with their respective definitions, and then examines the convergences and divergences implied by these definitions. Although often used interchangeably, the two terms are by no means equivalent.

Genius

The concept of genius has undergone a substantial change over the course of history. The word originated in Roman times. According to Roman mythology, each man was born with a genius that represented a kind of guiding spirit or guardian angel. A man's genius is what made him distinctive – and exerted some influence over his fate. Although the parallel tutelary spirit for women was a “juno,” this gender-differentiated usage did not survive to modern times. Interestingly, not just individuals had a genius. Particular places might have genius loci that served as protective spirits. And a Roman clan, caste, or group of families could also have a genius. Although the connection is not completely secure, the Latin word may be related to the Arabic “jinn,” often translated into English as “genie.”

Over time, genius became dissociated from the spiritual world. Instead, it became something highly characteristic of a given person, especially with respect to some unusual ability or inclination. Someone could have a genius for making friends, for example. In line with this usage, anyone could have a genius because genius is what defined one's individuality. But since the Renaissance, genius began to acquire a more restrictive meaning. As a result, only an elite subset of the human population could be said to have genius. In particular, a person could only be considered a genius if he or she exhibited exceptional intellectual or creative power. Uniqueness or individuality was insufficient.

At first, the emphasis seemed to have been placed on the creative powers. For this reason, perhaps, genius was initially confined to artistic domains of achievement. William Shakespeare and Michelangelo Buonarroti could thus be considered geniuses. Scientific creativity, by comparison, required no genius because science relied solely on a method that could be taught or imitated. For

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instance, Immanuel Kant argued, in his *Critique of Judgment*, that even a scientist as great as Newton could not be considered a genius because someone could theoretically learn to do what he did. Artistic geniuses, in contrast, invent their own rules, unconstrained by logic and fact. Nonetheless, eventually genius came to be found outside of the arts, including in the sciences. Indeed, after a while it became reasonable to speak of military genius, political genius, and the like. Sometimes the term even became overextended. Galton's, 1869 *Hereditary Genius* includes athletes along with generals, scientists, philosophers, artists, and composers.

These etymological developments lead to the most critical question: How can genius be given a definition suitable for scientific research? Stated differently, is it possible to devise a definition of genius that supports precise measurement? The answer is affirmative but plural. Researchers have tended to use two rather divergent definitions of genius, namely, the historiometric and the psychometric.

Historiometric Definition

Galton was the first to define genius in terms of historical impact. A genius was someone who had acquired an extraordinary reputation for culturally valued achievements. This reputation was first established with contemporaries but was later consolidated by the posthumous appraisals of posterity. Given sufficient time, the judgment of an individual's contributions to civilization should become reasonably stable. Certain reputations will have withstood the "test of time" whereas others will have "fallen by the wayside." The question was then how to assess whether or not a particular individual could claim sufficient reputation to be counted as a genius.

Galton's solution to this problem was to adopt a crude eminence measure [see Eminence]. A person who was featured in a major biographical dictionary had a *prima facie* justification for being considered a genius. An alternative solution was proposed by Galton's contemporary Alphonse de Candolle (1873), who introduced awards or honors as the criterion of distinction [see Awards]. More specifically, Candolle studied scientists who were sufficiently illustrious to earn election to a prestigious scientific society. Galton later endorsed this criterion as a reasonable alternative to his original measurement strategy.

Even so, both of these measures had a drawback: They did not admit of degree. Geniuses can differ in the magnitude of their genius. Not all persons with entries in a biographical dictionary are equally eminent. Galileo Galilei certainly surpasses Evangelista Torricelli, just as Fyodor Dostoyevsky outshines Aleksandr Kuprin. Similarly, not all recipients of a given honor or award are of equal standing as geniuses. Albert Einstein received the Nobel Prize for Physics one year after the same award was bestowed on Charles Edouard Guillaume. Whereas the former laureate revolutionized our conceptions of matter, light, space, time, and gravity, the latter laureate merely discovered some anomalies in nickel steel alloys.

The first researcher to offer a quantitative rather than qualitative measure of genius was James McKeen Cattell. In 1903, he ranked the 1000 most eminent creators and leaders of Western history based on the amount of space devoted to each luminary in standard reference books. According to his sources, the most space was devoted to Napoleon and Shakespeare, the least to Barthélemy Prosper Enfantin and François-Noël Babeuf. Later investigators refined this approach, especially Frederick Woods, who was the first to refer to such measures as historiometric [see Historiometry].

Cattell also introduced an alternative method for the historiometric definition of genius: expert surveys. He would ask experts to evaluate the relative impact of eminent scientists. This approach has also been used frequently to assess the differential influence of achievers in a variety of domains, including classical composers and US presidents.

The above two historiometric definitions are not equivalent. Space measures tend to have much more skewed distributions than do expert evaluations. Even so, they correlate very highly, the top figures by one assessment tending to be pretty much the same as the top figures by another assessment. Just as important, historiometric judgments tend to be highly stable across historical time, even after the passage of a century or more.

Psychometric Definition

The historiometric definition of genius is clearly sociocultural rather than psychological. Reputation is irretrievably contingent on the opinions of others. Scholars have to decide how much space to assign entries in biographical dictionaries, and experts have to assess the relative impact of various contributions. Nevertheless, Galton believed that an achiever's reputation was directly related to his or her personal qualities. In particular, he attributed genius to high natural ability. The latter was a complex concept that included intelligence, energy, and motivation. Even so, it is clear that Galton viewed intellect as primary. Human beings varied greatly in natural ability, and this variation was quantitative rather than qualitative. That is, each individual could be placed on a continuous scale with the least able at the bottom and the most able at the top. In addition, Galton introduced an important innovation: the concept of the normal distribution, as described by the "bell curve." Although Adolphe Quételet had shown that many physical characteristics, such as weight and height, were normally distributed, it was not until Galton that psychological attributes were said to have the same distribution. He went even further by specifying that geniuses represent the upper tail of this normal distribution. That is why geniuses are so rare.

Unfortunately, at the time that Galton advanced this concept of genius, no instruments existed by which he could directly measure natural ability. So he was obliged to devise his own instruments, eventually producing a large number of "anthropometric" measures. These assessed individuals on visual and auditory acuity, reaction times, breathing power, strength, height, and weight – attributes that do not seem to have an obvious link to natural ability. In fact, these measures were later shown not to correlate with anything that would be associated with intelligence, even less with genius. As a consequence, Galton's instruments could not provide the basis for a psychometric definition of genius.

The needed measures came from an unexpected quarter. In the early 20th century, [Alfred Binet and Théodore Simon \(1905\)](#) devised an intelligence scale that assessed a child's mental age. [William Stern \(1914\)](#) later conceived the idea of dividing the mental age by the chronological age and then multiplying the result by 100 to yield an intelligence quotient, or IQ. Not long after, [Lewis M. Terman \(1916\)](#) adapted the Binet-Simon for use with English participants, implementing Stern's concept of the IQ. In the early 1920s Terman applied the resulting Stanford-Binet Intelligence Scale to a large sample of young children. Those with IQs of 140 or more were then subjected to an intensive longitudinal investigation. The study was published in a series of volumes under the title *Genetic Studies of Genius* ([Terman, 1925–59](#)). The criterion of IQ 140 thus became the psychometric definition of genius. This cut-off even found its way into some standard dictionaries.

Of course, such a threshold is necessarily arbitrary. It defines those individuals whose IQs are in the top 1% of the general population. Certainly alternative cut-offs might also be justified. Mensa, the organization for high-IQ people, requires that a member only be in the top 2% of the population, whereas membership in the Triple Nine Society demands a score in the 99.9th percentile. Even more extreme, the Mega Society sets the IQ requirement at the 99.9999th percentile! Because standard intelligence tests do not yield scores high enough, candidates for membership must take specially designed tests.

Given the psychometric definition of genius, the person with the highest recorded IQ would be considered the world's greatest genius. Marilyn vos Savant was once listed in the *Guinness Book of World Records* as having that distinction, with a putative score of 228. Although both the claim and the score are controversial, she does illustrate an important point: Psychometric genius does not always correspond to historiometric genius. Since 1986, her chief claim to fame has been the column "Ask Marilyn" that appears each Sunday in *Parade* magazine. Here she answers questions and solves puzzles posed to her by the column's readers. She has not yet made a single contribution that would make her eligible for the distinction of being called a genius in the historiometric sense. Her situation can be contrasted with that of her husband Robert Jarvik, who attained some degree of eminence as the inventor of the Jarvik artificial heart. Stated differently, Jarvik's claim to greatness is probably higher than vos Savant's even if the latter has the higher IQ.

Greatness

The concept of greatness is strongly associated with what was once called the Great Man Theory of History. In this view, history is essentially equivalent to the biography of a few "great men" or "heroes." This theory is often credited to the British historian Thomas Carlyle, who expounded the position in his 1841 book *On Heroes, Hero-Worship and the Heroic in History*. He devotes considerable attention to such historic figures as Napoleon, Muhammad, Martin Luther, Jean-Jacques Rousseau, and Shakespeare, seeing them as decisive agents of civilization. Supposedly, the world we live in would be decidedly different if these individuals had died in the crib. A more recent illustration of this theory can be found in [Hart's \(2000\)](#) book *The 100*, which purports to rank "the most influential persons in history." The top figures on his list are Muhammad, Newton, Jesus Christ, Buddha, and Confucius. A glance of the complete 100 reveals that every one of these influential figures can be assigned to one of two categories of greatness: outstanding leadership and exceptional creativity. However, it must be recognized that another guise of greatness exists that cannot be included in either of these two categories, namely, prodigious performance. Below we examine all three forms.

Outstanding Leadership

Leadership has been defined many different ways. Some of these definitions have greater scientific utility than others. On the one hand, we might identify leadership with some mysterious property that only certain great persons possess, such as charisma, dynamism, or magnetism. These highly romantic conceptions of leadership have immediate appeal, capturing as they do some popular myths about great leaders. However, such notions do not have much precision. Accordingly, these ideas do not lend themselves to measurement, and if scientists cannot measure an attribute, they cannot really study it.

Hence, leadership researchers tend to adopt a much less romantic conception of the phenomenon. Given a group of individuals, leadership is defined according to the magnitude of influence a given group member exerts over group problem solving, decision making, or cohesiveness. Although the person who displays the most impact is often called the group leader, groups can have more than one leader, and often do. For instance, one leader might be a "task specialist" while another would serve as the "social-emotional specialist." Where the former would focus on group decision making or problem solving, the latter would concentrate on maintaining group morale or cohesiveness. Naturally, the best leaders would exhibit the capacity to accomplish both ends [see Teams].

Defining leadership in this way leads quite naturally to a definition of "great leaders." The groups over which great leaders exert their influence are much larger, and the magnitude of that influence is much greater. The groups are whole nations, even civilizations, and the influence takes the form of new religions, laws, reforms, institutions, military victories, or territorial conquests. It is no accident that some of the highest ranked luminaries in *The 100* are religious leaders: Their impact often affected millions of people not only in their own time but also for centuries after their death.

Exceptional Creativity

The creative individual is usually defined as someone who can generate ideas that are both original and adaptive. However, both criteria are quantitative rather than qualitative variables. There are degrees of originality and degrees of adaptiveness. An idea might seem original to a person even if it is not original to others. And an idea might work for a person without working for others. For this

reason, it has become standard practice among researchers to distinguish between “little-c” and “Big-C” creativity [see Everyday Creativity]. The former involves the low levels of originality and adaptiveness that are sufficient for everyday life. An example might be a new recipe in response to some missing spices. The latter entails high levels of both factors. The levels may be so high that the ideas are deemed original and adaptive by many others, and perhaps even by a whole discipline, society, or civilization. Big-C creativity almost invariably results in the creation of a specific product, such as a poem, play, novel, painting, sculpture, design, composition, patent, monograph, or journal article. Furthermore, it is not enough to create a concrete product; it also must have impact. For example, a poem must be frequently anthologized, a composition must be often performed and recorded, and a scientific article must be cited by many other scientists. Indeed, at the highest level of creativity the product may become labeled as a masterwork or masterpiece.

It should be evident by now that Big-C creativity bears a striking conceptual relation with leadership. Such creators are in effect leaders, and the greatest creators are the greatest leaders. The main difference is the “group” that is the object of influence. A great filmmaker exerts influence over movie audiences and critics – and over fellow filmmakers as well. Moreover, the impact of the greatest creators, like that of the greatest leaders, withstands the test of time. Newton was listed among the most influential creators because his contributions to mathematics and physics shaped the course of history. Even Einstein was profoundly influenced by Newtonian physics. Einstein’s special and general theories of relativity only acquire importance in the context of Newton’s mechanics. One cannot launch a scientific revolution without having an established paradigm against which to revolt [see Paradigm Shifts].

Notice that Newton and Einstein exemplify another feature of truly great creators: Their impact extends beyond the specific domains to which they contributed. Both have produced ideas that became part not just of the larger intellectual community but also popular culture. The story of Newton discovering gravity while sitting under an apple tree and Einstein’s famous equation $E = mc^2$ are known to people who might never have had a course in physics.

Prodigious Performance

It was mentioned earlier that Galton included athletes among the “geniuses” in his 1869 *Hereditary Genius*. Specifically, he examined both oarsmen and wrestlers! Although it seems to be stretching the concept of genius to apply it this way, no reservations are required when we speak of greatness in sports. Athletes who receive Olympic gold medals, win world championships, or hold world records can certainly earn this status. Thus, in this sense, we can say that Michael Jordan was a great basketball player or that Joe Montana was a great quarterback. Furthermore, it is obvious that the epithet “great” can be legitimately assigned to other exemplars of prodigious performance. For example, we certainly speak of greatness in chess, and the term is no less applicable in the performing arts including acting, dancing, singing and instrumental performance. In general terms, if supreme performance in a given talent domain is recognized with trophies, prizes, or awards, it becomes appropriate to view the achievements as signs of greatness [see Awards].

In the case of outstanding leadership and exceptional creativity we add the proviso that the person must exert sufficient influence to earn the ascription of greatness. The same requirement might be attached to prodigious performance as well. To be great, the individual must inspire others in the same talent domain. For example, many violin and piano virtuosos have been inspired by the great Jascha Heifetz and Vladimir Horowitz, respectively. In sports, certain world records set by earlier great athletes can inspire their successors to strive to attain an even more impressive greatness. With the advent of audio and video recordings, it has become possible for somewhat ephemeral forms of achievement to provide inspiration for subsequent generations.

But must we consider all forms of prodigious performance to count as instances of greatness? There are certainly cases where we might wish to withhold the appellation. Should we count serial killers? Should greatness be ascribed to individuals who manage to make it into the *Guinness Book of Records* for feats such as stringing together the longest chain of paperclips in a 24-h period?

Convergence

It is possible to provide a convergent definition that combines the concepts of genius and greatness. The best place to begin is Kant’s definition of genius, which combines some of the features of the earlier definition of creativity with some of the aspects of Galton’s historiometric definition of genius. Kant said that geniuses must generate a product that is both original and exemplary. A product is *original* if it does not depend on the *imitation* of others, and it is *exemplary* if the product is so striking that it becomes an object of imitation by others. Although Kant confined his definition to artistic creativity, the restriction can be relaxed. Contrary to what Kant argued, Newton’s *Principia Mathematica* can be considered both original and exemplary. The work provided a new model for doing physics that dominated the field until the early 20th century. Even if Newton had to learn a lot of mathematics and science to conceive his masterpiece, the resulting product was by no means imitative. The work advanced well beyond its influences. At the same time, Kant underestimated the role of “imitation” in artistic creativity. Contrary to what he maintained, talent alone does not suffice to produce works that are both original and exemplary. Even artistic creators have to devote a considerable amount of time to mastering the necessary knowledge and skills. In fact, research has shown that it normally takes about 10-years of extensive learning and practice before anyone acquires sufficient domain-specific expertise to make superb contributions to a given domain (Ericsson and Pool, 2016). This 10-year rule even applies to child prodigies like Wolfgang Amadeus Mozart.

Indeed, we can contend that a product cannot be viewed as a work of genius unless that product represents a domain in which the 10-year rule applies, at least as an approximation. This requirement then rules out many of the achievements that populate the *Guinness Book of Records*. Whoever first came up with the task of stringing paperclips together in a 24-h period was certainly original, and the task later became exemplary, at least in the sense that the accomplishment inspired imitators who hoped to get their names in the record books. Yet it is patently true that the 10-year rule does not apply. It does not take a decade to learn how to form paperclip chains. Ten minutes is more than enough practice. Hence, even the originator of the Guinness category cannot be identified as a genius.

The preceding stipulation suggests another useful requirement. It is not just a matter that chaining paper clips requires no vast domain-specific expertise. It is also the case that it requires no exceptional intelligence to acquire and manifest that expertise. Many of the unusual feats in the record books do not require any more than an average intelligence even if they require more expertise than paperclip chaining. This observation certainly holds for most of the events that earn Olympic medals. To become a champion in shot put no doubt demands tremendous skill that is contingent on considerable practice, physical talent and dedication. Still, it is unlikely that shot putters must be extremely intelligent to attain mastery of the sport.

Therefore, we may add the requisite that genius can only be displayed in a domain in which expertise acquisition and manifestation presume an intellectual power far above average. This intellectual power does not have to be of the variety assessed in the typical IQ test. It could even represent a more specialized ability, as represented by one of [Howard Gardner's \(1983\)](#) multiple intelligences [see Multiple Intelligences]. Einstein's expertise acquisition would then have a different intellectual foundation than Pablo Picasso's or Martha Graham's. Yet the fact would remain that the domain-specific expertise that they acquired could not be attained and demonstrated by the average person on the street. Not everyone has the intellectual wherewithal to acquire and exhibit superlative mastery of physics, painting, or choreography.

By this point, we have said that genius requires the generation of original and exemplary products within a domain that presupposes the acquisition and manifestation of an intellectually demanding expertise. Such a conception would definitely apply to every major domain of exceptional creativity, whether scientific or artistic. Moreover, if the concept of products is broadened to encompass the principal acts of generals, politicians, diplomats, legislators, judges, and the like, then the same definition works for extraordinary leadership. As a case in point, Napoleon's battlefield tactics can be judged as both original and exemplary – to such a degree that his tactics became the objects of study in military science. The definition can also be extended to certain types of prodigious performance. Undoubtedly, chess champions who devise original and exemplary tactics would be considered geniuses. The same might hold for violin virtuosos who come up with original and exemplary interpretations of masterworks in the classical repertoire. Athletes in certain sports may also qualify if (a) their skills required a high degree of intellectual power and (b) their accomplishments proved both original and exemplary. An example might be a player in a team sport whose prodigious performance permanently changed the nature of the game.

Nonetheless, this inclusive definition might seem too inclusive. After all, might not a "criminal mastermind" count as a genius if the crimes displayed domain-specific expertise, intelligence, originality, and inspired numerous imitators? Although the answer would have to be affirmative, given the conditions, the criminal would be considered a genius of a special type, namely an "evil genius." [see *The Dark Side of Creativity*] More critically, we would not assert that the hypothetical individual exhibited greatness. That ascription cannot be applied because greatness presumes that the products of genius fulfill widely shared values. That is, the achievements represent contributions to society to a whole and not to some small group or individual that has what might be deemed a parasitic relationship with the larger society. Accordingly, the person credited with the accomplishment can be broadly taken as a role model for many others to follow. Stated differently, the genius who attains genuine greatness can be proclaimed as a sociocultural paragon – a person who exemplifies what is commonly taken as the best and the brightest. He or she inspires nearly universal admiration. Consequently, their portraits or images of their accomplishments more often end up on postage stamps, T-shirts, and even cartoons. The cream of the cream will have monuments built in their memory, such as the Washington, Jefferson, Lincoln, and Roosevelt memorials in Washington DC.

In the earlier discussions of genius and greatness, it was noted that these are quantitative variables rather than qualitative attributes. The same observation applies to the convergence of genius and greatness. The greatest geniuses are those who generate the largest number of original and exemplary products or acts that are widely admired as lasting contributions to civilization. For this reason, one-shot or one-idea achievers receive much less acclaim than those whose lifetime of notable achievements cannot help but provoke awe. Pachelbel's Canon in D is certainly a very pleasant work, but it is a rather small peg to hang a reputation on in comparison to all the masterworks generated by Johann Sebastian Bach. Worse yet, Pachelbel's best cannot really compare with Bach's best, so the former is overwhelmed by both quantity and quality. Necessarily, then, Bach must be credited with more genius and greatness than Pachelbel. This same contrast is applicable to great leadership and performance as well. Union General George Meade established his reputation for his defeat of Confederate General Richard E. Lee at Gettysburg, yet Meade's lone achievement pales in comparison to the multiple Union victories under General US Grant.

Divergence

The previous section just outlined how genius and greatness might be viewed as converging on the same exemplars of exceptional creativity, outstanding leadership, or prodigious performance. This integration began with Kant's assertion that genius produces works that are original and exemplary, and from there added domain-specific expertise, high intelligence,

productivity, and sociocultural value. Yet it must be recognized that this synthesis came with a price: Unlike the psychometric and historiometric definitions of genius, the convergent definition of genius and greatness does not lend itself to direct measurement. Some of the components of the definition are too elusive or vague, such as sociocultural value. For that reason, we have to ask how psychometric and historiometric genius compare with greatness.

Psychometric Genius Versus Greatness

We have put forward that bona fide genius demands sufficient intelligence to enable a person to acquire and manifest domain-specific expertise. So what is the minimum level of intelligence that would suffice? Creativity research has often suggested a threshold IQ of 120. If we take this figure to apply to various intelligences rather than just that intelligence tapped by IQ tests, then it should be apparent that a genius-level psychometric IQ is not necessary. Being intellectually gifted should be sufficient. Even so, this threshold must undergo two reservations.

First, different domains of achievement seem to have distinct lower bounds to the amount of intelligence required. Among leaders, military leaders appear to require less raw intellectual power than do political leaders, and less intellect is demanded to become a poet than a philosopher (Simonton and Song, 2009). In some forms of leadership, in fact, the relation may assume a curvilinear form so that an IQ beyond an optimal level will exert a negative effect (Antonakis et al., 2017).

Second, whatever the threshold level required for a particular domain of achievement, higher levels of appropriate intelligence are associated with higher levels of greatness. This positive relation was first demonstrated in Catharine Cox's classic 1926 study of 301 geniuses in which she estimated IQ scores using historiometric methods (see Historiometry). Moreover, the association has been replicated in several subsequent studies. For instance, it has been shown to hold for United States presidents, European monarchs, and eminent African American creators and leaders (Simonton, 2009).

The upshot is that psychometric genius has a weak but positive connection with greatness.

Historiometric Genius Versus Greatness

One would think that historiometric genius would come much closer to greatness than does psychometric genius. Where the latter is predicated on a test score of some kind, the former is based on actual achieved eminence, as gauged by historiometric measures [see Eminence, Historiometry]. In addition, it would seem that a luminary cannot attain eminence without producing something that satisfies the criteria that we have laid out for greatness. However, various other factors can undermine the degree of correspondence between historiometric genius and authentic greatness.

In the first place, individuals sometimes attain not fame but infamy. Not every person who makes it into the history texts, biographical dictionaries, or encyclopedias is placed there because they affirm certain sociocultural values. On the contrary, they are included as examples of what not to do – individuals to be eternally derided and damned. Benedict Arnold, John Wilkes Booth and Grigori Rasputin are illustrations. Significantly, one empirical study of 342 European monarchs looked at the relation between a ruler's eminence and his or her assessed morality or virtue. The relation was defined by a U-shaped curve. The most eminent were either highly moral or virtuous (the famous) or highly immoral (the infamous). In the history of England, a "bad king" like Richard III is about as well known as a "good king" like Henry V. A parallel pattern is seen in the United States presidency. Both good and bad presidents are better known than run-of-the-mill chief executives are, particularly when the failed administration resulted from a major scandal. Richard M. Nixon attracts more attention in the archival records than do many other two-term presidents.

Even worse, sometimes a person may attain distinction for reasons that have nothing to do with their actual achievements, good or bad. Shakespeare once wrote, "Some are born great, some achieve greatness and some have greatness thrust upon them." The first and last of these three alternatives present the biggest concern. A significant proportion of eminent personalities born prior to the 20th century were members of royal or aristocratic families. Even if some of these "blue bloods" eventually ended up being the agents of worthy deeds, and perhaps even works of genius, a large proportion entered the history books through an accident of birth. Even if royalty and the aristocracy are on the wane, that is no longer the only biological route to fame and fortune.

The third of Shakespeare's three alternatives is perhaps the most interesting. Sometimes people do score high on historiometric genius because of events or circumstances that thrust greatness upon them in adulthood rather than at birth. To illustrate, United States presidents who are assassinated in office are more likely to go down in history as great presidents – despite the fact that there is absolutely no evidence that they are better leaders. Similarly, European monarchs who suffer a violent death – by whatever means – are more eminent than those who die peacefully. Although such arbitrary influences are most conspicuous in leadership domains, they appear in creativity as well. Sometimes it is just a matter of being at the right place at the right time. Karl Guthe Jansky, an engineer for Bell Labs, was assigned the task of investigating the source of static that disrupted transatlantic voice communications via short-wave frequencies. Having shown that source of interference came from the center of the galaxy, he inadvertently became the founder of radio astronomy. Had his employers assigned him a different job, he would have been denied the opportunity to make the discovery, and someone else might have become the field's founder. Instances of utterly capricious serendipity are all too common, introducing an element of luck in historiometric indicators of genius.

Hence, once more, the association between historiometric genius and greatness is positive but weak.

Conclusion

Genius and greatness are both highly praiseworthy and intimately linked concepts. And both are closely connected with creativity. When we speak of creative geniuses and great creators, the distinction between the two becomes imperceptible. At that convergence, we can talk of individuals who generate works both original and exemplary in domains that presume that exceptional intelligence had been relegated to the acquisition of domain-specific expertise. Even though both constructs are also related to eminence, the relationship has some unpredictable ingredients that render it more ambiguous. Eminent creators need not be identical to creative geniuses or great creators. When we choose to incorporate psychometric IQ into the mix of concepts, the result is even more complex and ill defined. At present, it is impossible to determine whether the ambiguities can be resolved with additional empirical research. Perhaps the problem is more logical than empirical. The concepts of creativity, intelligence, eminence, genius, and greatness may need analyses that are more refined before their overlapping meanings can be precisely delineated.

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Giftedness

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Introduction

Both creativity and giftedness are seen as the driving forces that push human civilizations forward. It is not a surprise that scholars who wrote on the history of creativity and those on giftedness both refer to the Sputnik Era as a turning point. This is a specific time in which the need for creative thinking and gifted education was felt most deeply by Americans, which fueled the interest, funding, and scholarship around these two related disciplines.

The link between creativity and giftedness has intrigued many scholars in different fields for decades. Creativity has been one of the most frequently researched topics in gifted education. Dai et al. (2011) found that creativity was one of the four main research topics in gifted education between 1998 and 2010. As of October 22, 2018, the PsycINFO database yielded 2441 publications for the combination of the abbreviated keywords “gifted*” and “creativ*”, and showed a steady increase on these topics across decades. However, the lack of agreement on definitions of creativity and giftedness beclouds the nature of the relationship between two constructs. There is a consensus that they are neither perfectly overlapping constructs nor totally unrelated. Treffinger (2004) proposes 5 themes that are expository grounds of the relationship between creativity and giftedness:

Definition. Attempts to define these two constructs resulted in the curiosity of how these two concepts are related to each other. Although there are several theories on creativity and giftedness, it is accepted that cognitive, non-cognitive and contextual factors play critical roles in both of them. This agreement gave rise to multiple links between creativity and giftedness.

Characteristics. There are some indicators that both giftedness and creativity share in common which people are able to manifest in genuine ways. They might be seen in different ways at various times involving different styles. Treffinger also pointed out a shift from “level” approach to “style” approach for both concepts. In other words, the way you express your creativity is more prevalent than how much creative you are. This variety of expressions also implies that these common characteristics can be improved and open to development.

Justification. The importance of giftedness and creativity has become more prominent in education. Many studies have shown the value of creativity in life and work. In addition, recent theories of giftedness viewing creativity as a component of giftedness expanded the scope of giftedness. The new paradigm of giftedness emphasizes the importance of inclusive definitions, diverse skill-sets and a multifaceted identification process in gifted education. Thus, the inclusion of other factors such as creativity or task commitment makes giftedness more integral to education. As a result, teaching creativity in education help students demonstrate their gifted behaviors and equip them better for the requirements of life and work.

Assessment. Both giftedness and creativity can be measured in different ways. No single score provides a comprehensive measurement. The accuracy of assessment is enhanced with the use of multiple sources. Improvement of assessment tools is a key to developing a better understanding and examination of giftedness and creativity.

Nurture. Creativity and giftedness can be improved. Although changeability of giftedness may be controversial when giftedness relies solely on a single factor such as intelligence, recent views on giftedness agree that multiple factors play roles in expressing giftedness. For instance, in Renzulli’s Three Ring Model, higher task commitment or creativity is associated with higher level of giftedness. There are many studies that examined how creativity and giftedness may be supported through programs and interventions, some of which are discussed below. It is noteworthy that nurturing the context or climate can result in improvement in creativity and giftedness.

Evolution of the Concept of Giftedness

Early definitions and conceptualizations of giftedness relied on high intelligence as the major or sole criteria. This brought about a heavy, if not unique, emphasis on IQ tests as the major criteria of identification. Dai (2016) called this dichotomous view of

giftedness (gifted vs. non-gifted) which rests on IQ testing and other assumptions of general intelligence as the Gifted Child Paradigm. This paradigm which is based on categorization (gifted vs. non-gifted), homogeneity and permanency of giftedness gave rise to some concerns such as elitism and inequality because only a small proportion of students could have access to advanced learning opportunities. Diversity and richness of human potential were frequently ignored in this era. Even though Dai (2016) argued that this paradigm still exists, recently, there has been an agreement that giftedness should be explained with multidimensional approaches, rather than with a single focus or measurement. This agreement led to a paradigm shift from overemphasis in general intelligence to talent development as a complex developmental pathway that takes various domains and social and psychological factors into consideration. Thus, contemporary views of giftedness are more dynamic and socially constructed. Some even proposed the term “outstanding talent” instead of “gifted.”

In contemporary research and scholarship, giftedness is no longer considered a fixed state of being but a developmental set of behaviors. For example, Piirto's (2011) Pyramid of Talent Development explains the development of talents in any domain needs to be supported at many levels by different factors including genetics, personality characteristics, cognitive traits, talent, and vocational and environmental factors. Environmental aspects include home, school, community, gender, and chance.

Similarly, Hong and Milgram (2011) described three main factors that shape the talent development in their theory, Comprehensive Model of Giftedness and Talent (CMGT): cognitive ability, personal-psychological attributes, and environmental-social factors. Cognitive abilities involve analytical and creative thinking whereas personal and psychological factors include motivation, interest, and biological ability. Environmental and societal factors consist of school, society, or family. Based on these factors, talent is developed in two distinct types at various levels: expert talent and creative talent. Expert talent involves more analytical and practical thinking whereas creative talent is represented by generating new and original solutions to problems in a domain.

It is now clear that giftedness is no longer seen through a positivist perspective and domain-specific models have become favored in the field. The new trend is a social constructivist approach. Talent is defined, invented and then invested in by society. This is a more inclusive, diverse, equitable and comprehensive stance than the earlier concept of giftedness.

Creatively Gifted

Broadening conceptualization of giftedness resulted in the inclusion of creativity in the definitions and models of giftedness. This went so far that some researchers viewed creativity as the foundation of giftedness. Runco (1993) stated that creative potential is one of the most critical commonalities among the various domains of giftedness. According to Winner (2000), creativity is an essential component of giftedness within any domain.

Some claim that creativity is the final stage of giftedness after gaining excellence. For instance, Subotnik and Jarvin (2005) proposed that cognitive abilities are necessary but insufficient to reach the highest level of a talent which requires productivity and creativity. This proposition is also consistent with Bloom's revised taxonomy, in which creating is the highest of form cognition. According to this revision, creating is superior to other cognitive operations such as remembering, understanding, applying, analyzing, and evaluating.

Some researchers view creativity as a type of giftedness. Creative giftedness is defined as a superior ability to generate ideas, solutions, behaviors, and insights that are novel and worthy in a specific domain or several domains. On the other hand, such a person may or may not show superiority in other talents and abilities. This is an important point because noticing the creative ability may be difficult when other talent areas are not obvious. Creative giftedness may need to be complemented by intelligence in order to adapt to the environment or new situation. As Kim and his colleagues underline that “Creatively Gifted Students Are Not Like Other Gifted Students” in their book's title. This type of giftedness can be disregarded during the identification process because those who are creatively gifted have some different traits than other gifted types. For instance, academic giftedness is associated with convergent and logical thinking whereas creative giftedness is related to divergent and associative thinking and involves a high level of novelty and originality in their ideas. Moreover, these students may have characteristics such as independence, autonomy, and challenging the status quo, assumptions, and authority. It is likely that these may be perceived as negative traits in the school environment where discipline and classroom management are a priority. Therefore, some highly creative students may never be considered for referral to gifted programs as such traits may cast a shadow over their creative potential. In fact, some researchers (e.g., Westby and Dawson, 1995; Scott, 1999) indicated the possibility of a hidden bias against creativity characteristics among teachers.

This line of research is important because gifted education programs may unknowingly embrace a “schoolhouse giftedness” approach rather than “creative/productive giftedness” as Joseph Renzulli warned. Schoolhouse giftedness includes students identified by conventional IQ tests who have exceptional skills in academic giftedness. This form of giftedness is often demanded, appreciated, and emphasized in schools. Creative/productive giftedness refers to the ability to produce original and useful work. Children may be considered gifted as a result of their academic success whereas adults are seen as gifted based on their creative products. This distinction seems to explain why some children or adults fail to be identified as a gifted. Programs for gifted are best suited to serve schoolhouse giftedness leading creative individuals to be omitted from gifted programs.

Sternberg and Lubart (1993) argued that creativity involves different cognitive, personality, motivational and environmental aspects. They argued that creativity is more important than academic performance for the development of societies and proposed six resources that give rise to creative giftedness: intellectual processes, knowledge, intellectual style, personality, motivation, and environmental factors. Creative giftedness rarely occurs because these factors must interact effectively. Educational systems need to focus on these resources to develop creativity in children.

Milgram (1990) made a case that cognitive abilities don't correlate with real-life creativity and that creativity was a better predictor of life accomplishment than intelligence. In her 4×4 Model, giftedness has four different categories, two relating to aspects of intelligence (general intellectual ability and specific intellectual ability) and two to aspects of creativity (general creative thinking and specific creative talent). She also sees giftedness as a result of the interaction of cognitive, socio-personal, and cultural factors. It should be underlined that her model views creative thinking as a distinct form of giftedness.

Winner (1996) stated that few gifted children become creative adults. This might be because giftedness, as conceptualized without creativity, does not necessarily lead to future creative productivity. Creatively gifted students need more attention and opportunities to develop their specific skills such as music, mathematics or art.

Creativity in the Gifted Education Models

Since the Marland Report (1972), which provided the first definition of giftedness to modern gifted theories, creativity has always been a key construct in giftedness. The Marland Report included creativity along with other abilities such as academic and intellectual talent, leadership, art and psychomotor abilities to define giftedness. However, creativity was recognized as part of high ability in earlier works. The work of Louis Terman showed that gifted children in his sample had higher creativity with a longitudinal study of 1,500 children with IQ scores above 140. Divergent thinking (DT) tasks were part of the first intelligence test developed by Binet and Simon (1905).

One of the theories that connect creativity to giftedness is the three-ring conception of giftedness. According to the three-ring model, there are three major components of giftedness: above average ability, creativity, and task commitment (Renzulli, 2012). Giftedness is viewed as the combination of these three constructs and high intelligence and task commitment without creativity fall short of a full expression of giftedness.

Another crucial contribution by Joseph Renzulli is the Enrichment Triad Model (1977). This curriculum model offers school-wide, accessible forms of enrichment. Type I enrichment involves general exploratory activities that expose students to a wide variety of interests. Type II enrichment consists of group training activities to develop critical, creative and learning skills. Teaching creative thinking and problem-solving skills would be a primary objective of Type II enrichment. Type III enrichment involves working on real problems in a self-selected area using their experiences on Type I and II enrichment activities. Engaging in Type III enrichment is a creative experience in itself that requires the application of creative thinking and problem skills acquired in Type II enrichment.

In his Triarchic Theory of Intelligence, Sternberg (2000) identified three types of intelligence: analytic, creative and practical. According to this theory, various patterns of giftedness can be demonstrated within each or as a combination of these three areas. Creativity is seen as one of the crucial components of intelligent human behavior. Although creative abilities may lead to novel ideas, the creative process requires analytic abilities to evaluate the implications of those innovative ideas. Likewise, the creative process needs to use practical ability to persuade others that those ideas are better than old ones. Generating ideas (creativity), assessing the quality of these ideas (analytic) and then implementing these ideas (practical) give rise to giftedness.

Later, Sternberg added wisdom referring to the consideration for the common benefit of all stakeholders. Without wisdom, the gifted individual may make use of their intelligence to achieve selfish goals. As the name implies, the WISC model of giftedness (Sternberg, 2009) necessitates having high levels of wisdom, intelligence, and creativity. Giftedness should be extended for the common good of the world. Wisdom involves the application of both intelligence and creativity for the greater good of all. WISC can be helpful in developing gifted abilities.

According to the Star model (Tannenbaum, 2003), giftedness can be identified through five elements: superior general intellect, distinctive special aptitudes, non-intellective requisites, environmental supports, and chance. The non-intellective requisite includes creativity, motivation, self-concept, and any other individual characteristics that are not part of cognition. Thus, creativity is not included in cognitive abilities but is listed as one of the psychological factors. Gifted potential transforms into two different types of giftedness: producers and performers. Producers generate thoughts or things whereas performers apply or complete these thoughts or things. Creativity and proficiency are necessary processes for both producers and performers.

Gagné (2009), proposed some natural abilities that contribute to giftedness in his Differentiated Model of Giftedness and Talent (DMGT) model. These natural abilities which consist of intellectual abilities, physical abilities, creativity skills and socio-affective abilities are the building blocks to acquire the skills and knowledge related to expertise in a particular domain. Children can demonstrate their capability in all of these domains at various degrees but a child is considered gifted when the level of expression becomes outstanding. Gagné made a distinction between giftedness and talent: Giftedness can be defined as natural ability in a particular domain, whereas talent in a specific domain starts with natural abilities which are then steered by interpersonal and environmental catalysts and chance. So, natural abilities require the appropriate environment to be transformed into talents.

The Munich Model of Giftedness (Heller et al., 2005) proposed seven relatively independent predictors which include intelligence, creativity, social competence, practical intelligence, artistic, musical and psychomotor skills. So, creativity is one of the individual potentials that can transform into excellence performances in various domains depending on non-cognitive and environmental factors.

Summing up, creativity is present in the major models of giftedness. Some of them view creativity as an ability that is necessary to manifest giftedness and some others see it as complimentary skills leading to the superior manifestation of giftedness.

Giftedness and mini-c

As the concept of giftedness evolved, the concept of creativity has undergone some changes as well. One of the newest concepts in levels of creativity can be the conceptualization of mini-c which is the beginning point of the continuum of creativity (from mini-c, little-c, Pro-c to Big-C). Big-C, Pro-C, and little-c creativity have product-oriented focus distinguishing levels of creative magnitude.

The most relevant creativity concept to giftedness might be mini-c which is recently proposed by [Beghetto and Kaufman \(2007\)](#). Generally, creativity used to be assessed through creative products. Mini-c creativity, which is rooted in Runco's "personal creativity", represents novel and meaningful interpretations of experiences that can later be turned into little-c or even Big-C creative outcomes. Expecting Big-C or little-c from a sixth-grade student can be unrealistic but intrapersonal judgment or insights can be transformed into interpersonal (little-c) or historical (Big-C) productions. A singular focus on creative products may lead to a failure to recognize creative potential. Apart from being important indicators of creative potential, the concept of mini-c is important for educators to cultivate the creative potential in their classrooms. The idea of mini-c provides a new direction for developing identification tools of creativity or creative giftedness as well.

Nurturing Creativity in Gifted Learners

A critical challenge in gifted education is whether and how youth giftedness and creativity turn into adult productive creativity and expertise. It is clear that there is no one right way to cultivate creativity in gifted learners. Here are some promising approaches to foster creativity among gifted students.

[Sternberg \(2017\)](#) proposed the Active Concerned Citizenship and Ethical Leadership (ACCEL) Model which underlines the need for ethical leadership to achieve common good for all. He noted that gifted students are especially vulnerable to lack of foresight such as unrealistic optimism, egocentrism, and unethical engagement because they may believe that they are safe from these fallacies. Therefore, the ACCEL model of giftedness advocates for the development of analytical, creative, practical, wisdom-based and ethical skills among gifted students.

Our societies face complex social issues that need solutions. Instead of being separated from society, gifted students should be educated as expert real-world problem solvers. They need to be taught critical and creative thinking, common sense and wisdom. [Sternberg \(2017\)](#) argued that we should concentrate on preparing gifted students to become transformative and ethical leaders who have analytic, creative, practical, wisdom-based, and ethical skills rather than focusing on traditional IQ-based approaches. In this model, taking responsibility in a family is an important leadership role. So, the quality of leadership matters rather than the level of leadership. Sternberg emphasized the importance of ethical skills that focus on decisions made by focusing on the right thing is to do, not just the benefits of shareholders and consumers.

[Beghetto's \(2017\)](#) legacy projects seem to be in line with the ACCEL model. Legacy projects are student-directed, creative efforts to make positive change by focusing on complex challenges in students' environments. These projects require gifted students to work on real-world problems and to cooperate with others to find solutions. While tackling ill-defined problems, they should think and act creatively. Therefore, legacy projects can provide students with first-hand experiences of developing their creativity and problem-solving skills. Beghetto uses these following questions to design a legacy project addressing problem identification, developing a rationale for the importance of these problems, taking actions to do something about such problems and planning for ways to sustain and maintain the work:

- What is the problem?
- Why does it matter?
- What are we going to do about it?
- What lasting legacy will our work leave as a result of addressing this problem?

The Future Problem Solving Program (FPSP) was developed by E. Paul Torrance to teach students to use creative problem-solving skills on complex challenges of the future. FPSP helps gifted students increase their awareness of critical issues and adapt to a changing world and turn the challenges into creative solutions. Students apply creative problem-solving skills when solving a real-life problem in each of the FPSP components. For instance, global issues problem solving requires students to employ creative problem-solving processes to respond to some future global scenarios. In community problem-solving, students examine their societies and develop a project to find solutions to community issues and then implement their plans. Scenario writing asks students to write a futuristic short story based on their future projection of given issues. In scenario performance, students create and perform a 5-min oral story on one of the given topics. Action-based problem solving is developed to master creative problem-solving steps in classrooms.

Conclusion

Most contemporary theories of giftedness view creativity as a core component. Creativity is more important today for gifted education than ever before because the future is unpredictable and change is occurring faster than ever. It is important that educators pay recognize students with high creative potential. Gifted students should be given opportunities to cultivate and enhance their creative

thinking skills as part of their differentiation and enrichment activities. Educators should develop programs fostering creative thinking skills.

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Good Work in Pre-collegiate Education

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The world needs creative people who generate novel ideas and think creatively to cope with the ever-changing world. Society also needs more good workers who get things done, and done well despite challenges and difficulties, not only to satisfy their own needs but also for the benefit for the society in the long run.

Creativity, as agreed among most creativity scholars, carries two core elements: originality and quality. The second element, quality, has many variations, such as usefulness, appropriateness, effectiveness, or aesthetic appeal, depend on the domain in focus (Runco and Jaeger, 2012). Creative thinking process often involves some-levels of rule-breaking or deviation from the standard. There is no ethical standard necessarily binding on creative individuals, nor creative acts and products. In other words, creativity can be used in both constructive and destructive ways, depending on who operates it, either in accordance or defiance ethnic principals, to achieve either ethical or evil goals.

A new body of literature called Good Work examines the positive or ethical aspect of creativity. This emerged in the late 1990s. Most if not all scholarly publications in this area have been produced by scholars associated with the Good Work Project, led by three psychologists: Howard Gardner, Mihaly Csikszentmihalyi, and William Damon. The Good Work Project was a large-scale effort to identify individuals and institutions in various domains that exemplify good work – work that is excellent in quality, socially responsible, and meaningful to its practitioners. An ultimate goal of the Good Work Project is to determine how best to increase the incidence of good work in our society (The GoodWork Project Team, 2008).

The initial construct was called “humane creativity,” or socially responsible creativity, the kind of creativity that not only satisfies personal or an institutional interest but is done for the benefit of a broader society for a long run (Gardner, 2010). The concept was gradually evolved to good work to reflect the missions of the project better; that is, to understand what and how leading professionals or exemplifying workers do to make a difference in their jobs and how to increase the incidence of good work in our society (The GoodWork Project Team, 2008). Whereas creativity does not require an ethical standard binding on individuals, professionals (the workers) usually have a social contract binding them to a set of standard that benefits society. The word for creativity was eventually replaced by “excellence” to stress the technical aspect of the “work,” while two other Es were added: “ethics” and “engagement” to emphasize both social and personal meanings of the work. The definition for good work, therefore, requires three aspects: (1) technically excellent, (2) personally meaningful or engaging, and (3) being carried out ethically. The concept was best illustrated using three intertwined spiral chains, similar to the DNA helix, which they call the ENA.

The objectives and the score of the good work projects focus on two major themes, one theoretical and the other more applied. The first theme is to investigate the meaning of good work in different professions (also called the domains) and how successful individuals and institutions in different domains carry out good work in the face of intense, and often conflicting pressure. Through this line of research, prototypes of good work carried out by good workers may be established. The second theme is to develop the Good Work Toolkits based on the outcome from the first theme and, in working with individuals and agencies who are in charge of training young professions, to apply these toolkits to train future good workers in different domains (Gardner et al., 1997, 2001).

Since the late 1990s, a vast amount of empirical studies have been completed using the Good Work Framework developed over the years. The primary approach of the framework is to use semi-structured interviews with outstanding professionals in different domains, averaging 2 h in length, to create a rich database that can be mined in many ways both for the time of the study and for other researchers to explore in the future. Each research project may have its own objectives, but the framework provides a foundation for researchers who conduct the interview studies in various stages including drafting interview questions, choosing a sample, conducting the interview, and finally coding and analyzing the data. For example, under the framework, interview questions are designed to cover nine major topics ranging from beliefs and values, work process on the personal level, positive and negative pressure at work, formative background, perspectives on work, community and family relationships, and ethical standards. Interviewees are typically informants who are experts or a representative sample of the examined domain. There are recommendations on how to conduct the interviews.

After the interview, the audio materials are transcribed into text and reviewed by the interviewees before being converted into standard format of transcripts following a general coded reading guide. This conversion procedure is regarded as the first level of coding to ensure the most important information is captured and placed under the most appropriate heading. After the first step coding, the converted transcript is further coded based on a coding manual, which contains 3–5 pages of information arrayed on 10–20 coding sheets. The coding manual contains detailed instructions on how to code the transcript as well as precise definitions and examples of their pre-determined 11 codes (Gardner et al., 1997, 2001). Coders were trained through ongoing discussion and testing to refine and clarify codes. Multiple round of training ensure a satisfactory and stable inter-rater reliability.

This standard procedure for all interview studies produced by the Good Work Project allows researchers to identify variables clearly and to address different questions at different stages of the research. Some recorded texts are descriptive to be used as testimonies in the report; others allow for further analysis of the data via descriptive and inferential statistics. This procedure can effectively reduce the amount of descriptive information so that all researchers may explore the rich data now and in the future to examine relationships among different variables. For example, in a study to investigate how certain individuals succeed in devising

strategies that are both creative and socially responsible, researchers followed the framework to code the materials, which allow future researchers to reanalyze the data to examine other questions.

Additionally, the Good Work Project supplements the interviews with other sources of information such as examining their creative works, talking about the work with informants, as well as participating in a follow-up survey, asking them to rank order 30 values held by them and by other professionals. Examples of the 30 values are broad interests, challenge, courage or risk-taking, faith, fame or success, self-examination, social concerns, and vision.

The empirical data accumulated in over two decades are enormous and open to many possibilities. For example, in its first ten years, the Good Work Project had interviewed over 1200 professionals across nine different domains, including genetics, theater, journalism, law, medicine, pre-collegiate education, tertiary education, philanthropy, and business (Gardner, 2010). More professionals were surveyed and interviewed in the next decade, including those who are in digital media, the arts, sports, interdisciplinary work, and other domains. Toolkits have been developed and utilized in various domains. Comprehensive reports and a systematic collection of books and research papers are available on the Good Work Project website, separated by the domain of focus (available via goodworkproject.org).

It is neither possible nor necessary to provide an overview of the vast amount of work produced under the Good Work project. Instead, this entry to the Encyclopedia examines one domain, pre-collegiate education. This provides a glimpse on how good work is empirically examined and what practical implications can be derived to help readers to appreciate the work and explore this line of research.

When examining the good work in the domain of pre-collegiate education, we focus on introducing three areas of research: (1) what are some challenges and ethical dilemmas educators and students face when thriving for success, (2) what is the meaning of good education and how educators carry out good work when external conditions work against them, and (3) the Good work toolkit in pre-collegiate education and how to use it to train future good students and good teachers.

Like in any other domains, individuals and institutions in pre-collegiate education face their challenges to meet professional and ethical standards. This becomes especially difficult when higher education has become more and more commercialized. The increasing market driven efforts in higher education has a ripple effect to pre-collegial education that challenges both educators and students to stay focus on their educational goals and personal passions, rather than giving in for a short-term goal and simply doing compromised work. Several studies were conducted to address this pressing issue.

Using the Good Work Framework, Redding (2010) examined the state of for-profit college counseling in the United States. She interviewed 13 stakeholders of the field, who play critical roles in either college admission process or in regulating the profession. These interviewees include leaders in professional organizations, partners in certificate programs, deans of college admissions, independent counselors, and scholars. The results are quite alarming. Although professional organizations encourage ethical, engaged, and excellent work of college counseling, there is a lack of gatekeepers' level of regulation to the field, especially for those who do not join these organizations. There is no required core knowledge for individuals entering the field of counseling, nor a strict requirement of professional membership to reinforce and sanction ethical guidelines to all professionals. The lack of field regulation leaves many unqualified consultants doing compromised work, and some even engage in dishonesty and manipulation, which leads to increased confusion, heightened frenzy, and continued inequity. Moreover, the consultants reshaped the process and expectations from the admission office, "enhancing the sense that there is a secret information" in college application.

Getting into good universities and exam culture creates challenges and dilemmas to educators not just in the United States but globally. Followed the Good Work Framework, Chia (2011) surveyed 20 Singaporean teachers and interviewed 10 of them to examine the impact of high stake exams on high school education. The result indicates that, although all interviewees believed that tests scores and student academic achievement are two separate things, they have to struggle to deal with the conflicts between helping students to excel in exams and providing good education. They also endorse that good education means to promote students' characters such as the spirit of curiosity, the quest for the universal human good, and healthy relationships that can last a long time and are for the benefit of the society. Chia asserted that schools, society, and national leaders should all play important roles in change the dilemmas and conflicts. A top-down initiative from the government is recommended to change the reality and to build "thinking schools" or eventually "a Learning Nation." In the end, Chia proposes a new model, adding enduring as a forth E, aside from excellent, engaging and ethncial, in promoting good work in pre-collegiate education in Singapore.

Increasing pressure of exam culture and the pressure of getting into top universities for future economic gains also affect student's good work in schools. Boddy (2015) surveyed 24 seventeen years old boys who are from a private high school in London and conducted a whole group discussion. The result indicates the exam culture left students little room for exploring their life's purposes and passions. Instead, students focus only on academics and allocate most if not all their resources into many extracurricular activities that could potentially help them to enter elite universities.

Even for those who are already admitted into elite universities, economic gain and career security may still drive students away from doing a good work. Locker et al. (2014) surveyed 40 Harvard seniors and interviewed seven of them. The result indicates the existence of "funnel effect" – an effect that more and more students chose to select a few careers with a higher economic gain. More specifically, the results showed that many humanity-major students chose to pursue a career with a higher payment such as finance and consulting; rather than related fields such as history and language that interest them at the first place.

The best approach to understand the good work in any profession is to get a perspective from outstanding professionals who are more knowledgeable about the good work in the profession. Fischman (2006) interviewed 16 informants – leading experts who are

working in the field of education. The result indicated that the informants rarely agree on some fundamental questions such as the purposes of education, the definition of good teaching, motivation to carry out good teaching under pressure and challenges, as well as methods used to improve the quality of education. Nevertheless, three areas of education are identified as important factors to assess good education, which are, structure changes in schools, quality of instructional practice, and student engagement and teacher-student relationship. These three factors are agreed among major stakeholders of education, such as administrators, educators, superintendents, parents, government, and school reform experts.

Applying the knowledge learned from their research to practice, the GW Project developed a series of toolkits to engage individuals and groups in conversation and reflection about good work. The first toolkit was published in 2010, which contains a guidebook filled with narratives and dilemmas faced by workers, a book of 50 narratives selected from 1200 individuals interviews over the 10 years, and a set of cards with varying values on each intended to be sorted into most to least important. Since the introduction of the toolkit, it has been used in different settings including high school and college classrooms across the globe.

The toolkit was also modified to adapt to younger audience including elementary school students to emphasize the message that carrying out responsible, high quality, and honest work is important at any age, and the younger students begin to appreciate ethics, excellence, and engagement as workers and citizens, the more powerful their understanding will be. All the narratives and activities were revised to adapt word choice and ideas suitable for a younger student. The toolkit was further developed as a set of lesson plans to be used in both upper grade elementary school students and middle school students.

Sample toolkits and lesson plans are available on their website at <http://thegoodproject.org/toolkits-curricula/the-goodwork-toolkit/>. Through developing these toolkits and lesson plans, the GW project formed collaboration with schools both within the United States and around the world (Fischman, 2010). The extent to which the toolkit can be generated in the global context is still in investigation. Nevertheless, toolkits have a lot of potentials in the field of pro-collegiate education, which primary objectives to train future good workers who can contribute positively to our society as well as fulfilling their personal goals.

In this chapter, we introduced the background of good work, its origins, and framework for conducting research in this area. We also provide a brief summary to research on good work in the domain of pre-collegiate education. So how to evaluate the 20-year research in good work and what lessons do we learn from this body of research?

First, how do insiders view the accomplishment of the GW Project? Have they achieved the goals they have set up initially and what kind of work left for the future?

The GW Project generated plenty of interests both within the academic circle, including the field of creativity research and education, and public and applied sectors such as schools, companies, and policy makers. This can be seen from the reception of the work from audiences at professional conferences, the expansion of its theory and framework, as well as increasing collaborations from various individuals, groups and institutions to attempt work together to execute good work, teach the topic, and apply the theories in different educational realms. Most importantly, the questions the project asked and the ongoing dialogue it nourished have a far-reaching effect for both academics and the general public (Gardner, 2010).

However, despite the enthusiasm scholars and publics have demonstrated when knowing about the work produced by the Good Work Project, there are still lack of recognition from both the field of psychology and the general public (Csikszentmihalyi, 2010). Most research papers are yet published in peer-reviewed "A Class" journals. Publics and applied sectors are also struggled to embrace the findings of the project. For example, several projects were developed to get perspectives from both educators and students about what the purposes of education are and what actually students got. The results showed a misalignment between the educators and the students on these questions. Whereas educators endorse a notion that an important objective of education is to provide students with cognitive tools like critical thinking and analytical skills, students emphasize more on learning how to live a good life, a goal that educators often deemed as hedonistic. When such results were shared with stakeholders in a hope to diminish the gap between educators and students, there lack of acceptance to address this issue from the school administrators.

For those who are interested in joining the dialogue of good work and become a researcher in studying good work, we would like to make two recommendations based on what we've learned from the 20 years in good work.

First, the field of good work is still a new and growing research area. It addresses important academic and social questions that can have a long-lasting impact on the field of psychology and many other fields. The specific research questions GW scholars have asked are profound and often challenge the core of a discipline. For example, in the domain of education, researchers ask questions such as the definition of good education and the ways to execute a good education in the face of intensive conflicts and pressures. All these questions are hard to study using conventional methodologies. To respond to this, the GW Project develops a framework to examine these questions systematically. The results often lead to many new questions than answers. The project has generated a rich database to allow future researchers to reanalyze and address further questions. At this stage, more research is needed to further examine the GW theory as well as its framework. More practitioners are also needed to apply the knowledge gained from previous studies to change any unfavorable reality of our society, which will help train future good workers.

Second, as mentioned at the beginning of this article, most if not all studies are produced by scholars associated with the three psychologists. A PsycINFO search with a keyword of "Good work" only yielded 19 entries and most are unrelated with the GW work introduced in this article. This feature suggests that the field of good work is very much self-sustained. The usage of qualitative methods and the adoption of a comprehensive framework make replications harder. Nevertheless, for the healthy growth of field, more independent research is needed to verify findings from the GW project.

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Government

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Introduction

Creativity and innovation are necessities for development and survival in a modern world where problems and challenges such as war, disease, and global warming are complex and come with unpredictable consequences. In many aspects of life, from economics to politics, and from education to the sciences, governments need to set up clear and explicit strategies that consider creativity as a corner stone. If they do not place creativity, a prerequisite for innovation, as their highest priority, policymakers cannot expect workers or employees to behave creatively and accept creative change. Governments that believe creativity is a valuable human resource will invest and support creativity in their plans and initiatives.

Geographic size or population of a county is no longer a salient feature; on the contrary, national assessments feature economic, technological, and educational indicators. Creative and talented individuals create soft power for small countries that design their economy and address intractable environmental problems.

For example, Singapore, a small country in Asia that has few natural resources, is competing with the richest countries. The Global Innovation Index ranking (GII; 2018) placed Singapore in fifth place, outperforming many rich countries such as the United States, Germany, France, and Japan. Moreover, Singapore is ranked first in the Innovation Input sub-index of the 2018 GII report. How could a small country such as Singapore compete with much bigger economies? One of the answers can be found in the Research Innovation Enterprise 2020 Plan in which the Singaporean government assigned \$19 billion of its budget to support research, innovation, and enterprise. According to the National Research Foundation Plan, four categories of researchers were supported: (a) early career researchers, (b) mid-career researchers who are expected to become scientific leaders in future, (c) multi-disciplinary teams conducting cutting-edge research, and (d) outstanding Singaporean researchers who have established themselves abroad with the opportunity to relocate their research back to Singapore. Other examples of governments supporting creativity and innovation are the Dubai government through their Mohammed Bin Rashid Center for Government Innovation, the Canadian government through its Innovation, Science and Economic Development program, and the United Kingdom Research and Innovation Agency. These, and other examples of institutes that invest in creativity and innovation help explain why some countries are taking the lead in terms of economic status. Moreover, these examples demonstrate that supporting creativity should be a systematic and a planned effort by the highest authorities within the government.

This entry synthesizes and summarizes the current governmental efforts to support creativity. The following topics will be addressed: (a) discussing individual and organizational creativity, (b) comparing creativity in the public with private sector, (c) supporting creativity in k-12 education, (d), discussing environmental factors that encourage creativity in the government, and (e) supporting creativity research. Building on the previous sections, the final part of this entry concludes by offering a suggested definition for the term "creative government." It also provides some ideas for governments that aim to invest in creativity and innovation.

Individual and Organizational Creativity

The majority of creativity research during the last six decades focused on the individual level rather than the broader organizational level. The focus was on the characteristics distinguishing creative individuals, creative processes in which novel and useful ideas were being originated, transforming creative ideas into tangible products, and finding the ideal climate that fosters and encourages creativity and creative behavior. The past two decades witnessed an increase in studying creativity and innovation in organizations as

evidenced by books, book chapters, and peer reviewed articles. Moreover, policymakers have emphasized the value of creativity for social advancement and economic growth as reflected in their speeches, national plans, strategies, and reports (Runco, 2014; Runco and Abdulla, 2014).

Defining *creative government* is not easy at all. Perhaps some might question if such a concept exists. However, before defining creative government, it is important to define creativity in organizations as it is related to the context/nature of work in governments. Many creativity researchers are familiar with Rhodes 4P's (that is Person, Process, Press, and Product) in which an individual is the unit of interest and starting point for assessment. Still, there is a good reason to believe that what characterizes creative individuals applies also to organizational creativity. Amabile and Pratt (2016), for example, presented a dynamic componential model of creativity and innovation in organizations in which both individual and organizational creativity dynamically interact with each other. According to Amabile and Pratt (2016), creativity in organizations requires: (a) skills in innovation management, which corresponds with creativity-relevant processes in individual creativity; (b) motivation to innovate, which corresponds with intrinsic motivation in individual creativity, and (c) resources in the task domain, which corresponds with the third component of the individual creativity, skills in the task domain (see Fig. 1).

Some definitions of organizational creativity also showed that individual and organizational creativity are interrelated; both require originality and usefulness. For instance, Woodman et al. (1993) defined organizational creativity as 'The creation of a valuable, useful new product, service, idea, procedure, or process by individuals working together in a complex social context' (p. 293). Krueger and van Genugten (2017) suggested that "Work-related creativity is defined as an employees' ability to come up with new and useful solutions to improve work-related practices" (p. 826).

De Vries et al. (2014) conducted a systematic review on innovation in the public sector analyzing 158 articles published between 1990 and 2014. De Vries et al. (2014) defined innovation in the public sector as, "The introduction of new elements into a public service – in the form of new knowledge, a new organization, and/or new management or processual skills, which represents discontinuity with the past" (p. 5).

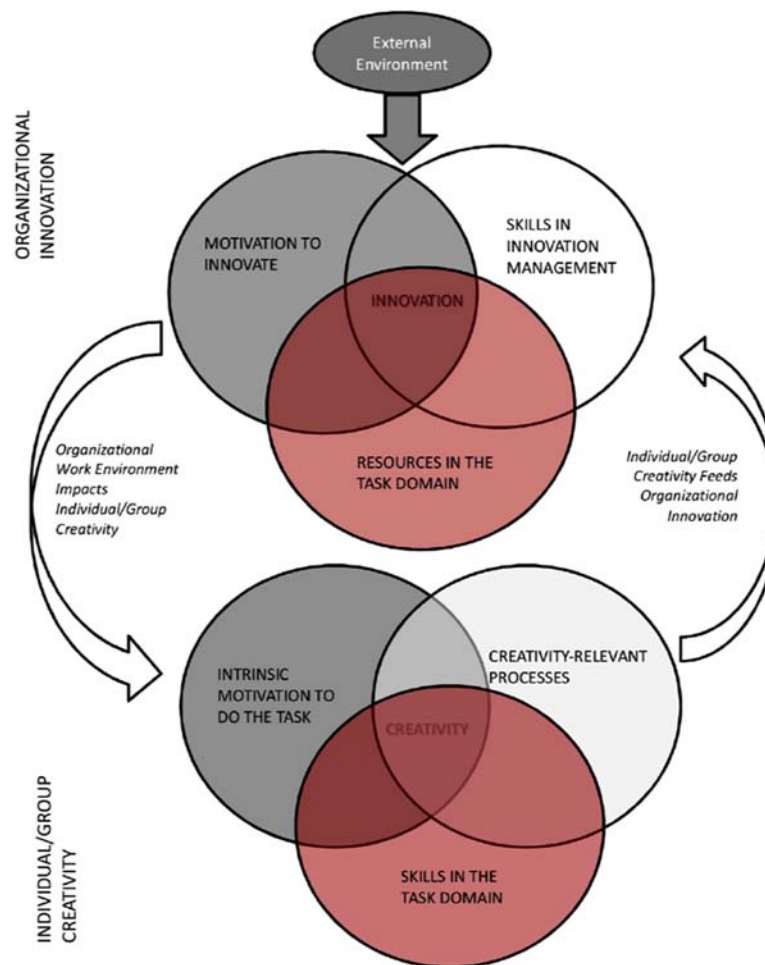


Figure 1 The dynamic componential model of creativity and innovation in organizations (Amabile and Pratt, 2016, p. 162).

Although, individual and organizational creativity operate in different ways and employ different dynamics, governments need to consider both individual and organizational creativity. More about the former will be discussed in 'supporting creativity in K-12 education' section. The next section explores whether creativity in the public sector (i.e., government) differs from creativity in the private sector.

Creativity in the Public and Private Sectors

Research investigating creativity and innovation in the public sector have recently attracted more attention (e.g., Rangarajan, 2008; De Vries et al., 2014) which allows researchers to compare creativity and innovation in non-profit and for-profit organizations. In the non-profit public sector, services such as education, healthcare, and law enforcement originate from public governmental sources; whereas, for-profit private organizations such as family owned business, medical partnership, and corporations such as Apple originate from private sources formed with the goal to make a profit. Empirical works indicate that there are notable differences between the public and private sectors such as the space and flexibility these two sectors allow for creativity and creative thinking, the process of decision making (i.e., centralized vs. decentralized), environmental and psychical reinforcements, expectations from employees to behave creatively, and sources of motivation (i.e., intrinsic vs. extrinsic) (Amabile, 1997; Damanpour, 1991).

Furthermore, literature on creativity and innovation in organizations point out that: (a) the public and private sectors operate under two different systems/dynamics, (b) there are different types of innovation in organization (e.g., radical vs. incremental), (c) the levels of innovation allowed is different in the public than private sector, and (d) the outcomes sought by each sector also differ based on each sector's nature and objectives. Damanpour (1991), who conducted a meta-analytic review on organizational innovation, reported that the relationship between non-profit and profit organizations significantly differed in: (a) functional differentiation, defined as 'the extent to which an organization is divided into different units; ' (b) formalization, which 'refers to following rules in conducting organizational activities; ' and (c) centralization, defined as 'locus of authority and decision making and the extent to which decision making autonomy is dispersed or concentrated in an organization' (p. 589).

Rangarajan (2008) concluded that the most frequent pairs of creativity in government are proactive creativity and forward incrementation creativity. According to Unsworth (2001), 'Proactive creativity occurs when individuals, driven by internal motivators, actively search for problems to solve' (p. 8), Sternberg et al. (2001) stated that forward incrementation creativity 'occurs when a piece of work moves a field forward in the direction the field already is going to a point to which people are ready to go' (p. 85). Rangarajan (2008) concluded that in most cases, creativity in the government was incremental and was perceived as a reaction to a problem rather than an opportunity.

These, and other studies support the idea that types of creativity in the public sector differs from creativity in the private sector. But what makes creativity and innovation in the public sector different than creativity in private sector? And which sector is more encouraging for creativity and innovative work behavior?

Tasaduq and Azim (2012) compared creativity levels between public school and private school children in India. They concluded that private school students scored much higher on a non-verbal creativity test than their counterparts in the public school. Tasaduq and Azim (2012) reported that environmental factors such as lack of sufficient opportunities, lack of encouragement, and lack of proper facilities characterized public schools. Rangarajan (2008) identified other factors characterizing public schools such as higher levels of scrutiny and oversight, lack of a competitive environment, cautionary culture, strict procedural regularity, preference for the status quo, legal restriction, and the short time horizon of politicians and top administrators.

In a study conducted with a different age group and context, Bysted and Jespersen (2013) compared public and private sectors in Denmark, Norway, and Sweden in terms of managerial mechanisms (i.e., financial, decentralization, and participative). More specifically, they looked at eight variables (salary bonuses, recognition, innovation trust, safety, autonomy, competence, idea generation, and idea realization). The differences were: (a) employees in the public sector were most likely to behave creatively when they were financially motivated (i.e., get bonuses), (b) decentralization mechanisms had a positive impact on workers' innovative behavior, (c) creating a safe environment for employees increased innovative behavior, and (d) employees in the public sector perceived innovative behavior to be something extra that needed to be rewarded while employees in the private sector thought of innovative work as an opportunity for their career development.

Finally, Fidan and Ozturk (2015) studied the relationship between intrinsic motivation and the climate for creativity for both public and private schoolteachers in Turkey. The results indicated that the private school teachers were more intrinsically motivated to be creative and scored higher on a creativity scale.

In sum, these findings suggest that the private sector offers a more encouraging environment for creativity and innovation than the public sector. The public sector run by government needs to find ways to build a culture that boosts creative and innovative behavior. Moreover, governments need to construct a system that encourages flexible thinking, autonomy, and risk taking. K-12 education is a good place to start.

Supporting Creativity in K-12 Education

In the past few decades, educators became more concerned whether educational systems are doing a good job preparing students for the unpredictable future. It is highly important that K-12 education provide students with the most advanced knowledge that keeps

them up-to-date, but the advancement of humanity was never made by those who possess/acquire knowledge; it is based on those who use the current knowledge to create a new one. This section is divided into two sections. The first discusses whether the educational system in K-12 education value and appreciate creativity or not, and the second shed light on the issue of investment on education.

Valuing and Appreciating Creative Thinking

There are so many ways in which governments, as represented by ministries of education can do to nurture creativity from childhood through adulthood. Perhaps the most important, and a prerequisite of any other effort to support creativity, is to value and appreciate creativity.

Torrance's well-known work on the fourth grade slump was one of the earliest attempts to shed light on the negative effect of educational systems on creative thinking. Torrance longitudinal study showed that there is a significant slump in fluency, flexibility, originality, and elaboration scores (Torrance, 1968). Torrance was explicit about the significance of valuing creative thinking:

It is my firm belief that every educator from kindergarten through the graduate school should always be on the alert to notice new ideas proposed by children and young people, and to encourage such individuals to continue the development of their creative talents. Every educator should consider this as important, or more important, than teaching information.'

Torrance (1995, p. 25)

Sadly, this is still not the case. Educational systems emphasize teaching information more than teaching cognitive skills including creativity. Some researchers found that educational systems slowly kill creative thinking. Kim (2011) found that creative thinking, as measured by the Torrance Test of Creative Thinking (TTCT), decreased in the sixth grade.

A recent investigation concluded that students display more creativity outside of school than inside school; something which authors called 'creativity gap' (Runco et al., 2017) In an international survey 1150 respondents consisted of teachers, students, and policymakers from 149 countries around the world, were asked the following questions: 'how well is the overall educational system in your country performing in teaching students the following: math, reading, science, technology and computer skills, teamwork, arts, physical well-being, environment responsibility, critical thinking, entrepreneurship and business, and innovation and creativity?' 75% of respondents indicated that their respective countries are doing only fair/poor job teaching innovation and creativity. Results per region showed that only 9% of East Asian countries are doing excellent/good job teaching innovation and creativity. The highest percentage was in US/Canada/Australia/New Zealand region; 49% of respondents think that their countries are doing excellent/good in teaching innovation and creativity. In sum, it seems that creativity is not valued as much as academic areas such as math, writing, and science. Thus, it is not surprising that many governments around the world are not well investing in education.

Investments in Education

A government that values creativity will invest in students creative potential. Potential refers to unrealized ability that can be developed in future. There is no guarantee that creative potential will result in future creative achievement. However, research indicated that creative potential, as assessed by divergent thinking tests can predict future achievement more than many cognitive abilities including IQ (Runco et al., 2010).

Investment in creative potential can take different forms such as: (a) infusing creative thinking skills in curriculums; (b) teaching strategies that aim to enhance creative thinking; (c) exposing students to different learning experience; (d) encouraging independence through different means such as school assignments and projects; (e) building a safe environment where students are allowed to make mistakes without thinking of being criticized or punished; (f) offering equipment and facilities that allow students to practice their creativity; (g) preparing teachers to deal with creative students, identify their creative potential and support it (see Education and Creativity).

A significant area of investment in education lies in establishing and supporting gifted programs. Although creativity can be observed in all students, special attention should be paid to girls or boys who show early signs of exceptional behavior. As Brody and Stanley (2005) stated: "Some individuals do have special talents, and recognizing and nurturing these talents is crucial not only for the individual but also for the future of society, as these individuals have the potential to be our future problem solvers" (p. 26). In fact, the notion of gifted education is based on identifying those students who show early sign of exceptionality (i.e., potential) in order to provide them with unique educational experiences that could potentially result in future creative achievements.

Data from the GII supported the abovementioned argument that investment in education is crucial and directly affects countries' creative outcomes. The GII 2018 report showed that governments in the top ranked countries invested more in education compared with lower ranked governments. For example, governments in Switzerland (#1), United Kingdom (#4), Finland (#7), and Denmark's (#8) expenditure on education ranged from 5.1% to 7.6%, as a percentage of their GDP while governments in countries like Philippines (#73), Pakistan (#109), Bangladesh (#116), and Guinea (#119) expenditure on education ranged between 2.4% and 2.8%.

This in turn influenced the pupil-teacher ratio. The more the government invested in education, the lower the pupil-teacher ratio. For instance, the pupil-teacher ratio in Switzerland, Denmark, and Finland was 9.3, 11.3, and 13.2 respectively, compared with the pupil-teacher ratio in Philippines, Guinea, and Bangladesh of 26.2, 33.1, and 36.2 respectively. To conclude, K-12 education needs to value and support creativity. Both are highly related; when you value something, you will invest on it.

Creative Environment

This discussion on creativity and government would be incomplete without addressing environmental factors that inhibit or facilitate creativity. The main question here is how governments can create an optimal environment in which individuals feel safe, supported, and motivated to behave creatively. Previous literature suggests that physical, contextual, and motivational factors all play an important role for both individual and organizational creativity. [Amabile \(1997\)](#) suggested six factors that encourage creativity: organizational encouragement, supervisory encouragement, work group support, sufficient resources, challenging work, and freedom; and two factors inhibiting creativity: organizational impediments, and workload pressure ([Amabile and Pratt, 2016](#)).

There are different ways in which organizations can cultivate employee creativity, many of which apply to government organizations. Among these are specifying clear organizational goals, valuing innovation, supporting risk-taking, rewarding and recognizing creative work, and evaluating employees' fairly. Moreover, public sector organizations can support creativity by offering sufficient resources and materials, sufficient time, access to information, training opportunities, and funding creative projects. To summarize, government that put creativity and innovation as a top priority should consider environmental factors including:

- Finding different ways to motivate workers
- Valuing creativity and creative thinking
- Offering a degree of freedom and autonomy for employees
- Providing sufficient materials, both physical and intellectual
- Rewarding and recognizing creative ideas and projects
- Offering challenging works for employees
- Considering the physical environment that encourages creativity
- Treating its employees fairly with clear criteria
- Providing advanced training for employees
- Encouraging diverse ideas and communication between employees in different departments

Supporting Creativity Research

The number of research grants allocated for creativity research is indicative of the degree to which governments value and support creativity. This investment can take different forms including supporting distinguished initiatives and programs that aim to enhance education, improve creativity and innovation, develop valid and reliable measures to assess creativity at the personal as well as organizational level, and fund research that aims to better understand and develop creativity and creative thinking. The latter issue is very important because good practices should be based on solid theoretical arguments. Supporting creativity research can save time and effort by suggesting what works and doesn't work in programs, strategies, assessments, and environments.

Are governments supporting creativity research, and to what extent are practices in the public sector research-based? This issue was empirically investigated recently through a number of studies, which examined award grants assigned for creativity research as compared with other topics such as intelligence, motivation, memory, and 21st century skills ([Abdulla and Runco, 2018](#); [Runco and Abdulla, 2014](#); [Runco et al., 2015](#)). The first of this series of studies examined the public records in two US government agencies: The National Science Foundation (NSF) and the Department of Education (DOE). The DOE offers two databases: Grant Award database and Institute of Education Sciences (IES) database. [Runco and Abdulla \(2014\)](#) compared the percentage as well the amount of fund granted for creativity research by the IES with other areas of study. The result showed that creativity research was poorly supported in IES (2.1%).

The same search was done for the NSF awards database for the period from 1961 to 2013. The results from the NSF was better than DOE in terms of the number of awards allocated for creativity research ($n = 310$), with an increasing pattern of grants for creativity research from 1961 to 2013, except a notable slump in the 1990s. Still, the percentage of grants offered by the NSF for creativity research was only 1.3%.

In the second study, [Runco et al. \(2015\)](#) adopted a different method by examining the three main journals in creativity from 2004 to 2013: *Creativity Research Journal*, the *Journal of Creative Behavior*, and the *Psychology of Aesthetics, Creativity, and the Arts*. Among the 707 articles reviewed, 159 (22.5%) of the articles were supported by different funding agencies in more than 20 countries, as indicated by the researchers in their footnotes. The majority of funds were offered by the public sector (72%). Examining the geographical region for these funds showed that Asian countries provided the largest number of awards (32%), followed by the US (31.1%), Europe (22.4%), and other countries (14.5%). The NSF and The Ministry of Education in China offered the highest number of research grants for creativity research.

Finally, [Abdulla and Runco \(2018\)](#) compared the award grants offered by the NSF and IES for the 21st century 4C's skills: creativity, critical thinking, communication, and collaboration from 2005–16. The results showed that NSF funded projects involving collaboration and critical thinking, while IES funded communication and critical thinking projects. Both agencies gave minor support for projects involving creativity; a result that is consistent with previous studies.

When listening to policymakers and reading what is written in government official documents, one might feel that creativity is a priority for governments. However, this is not the case. The conclusion is that creativity is anecdotally supported when it comes to investments in creativity and creative individuals. As [Runco et al. \(2015\)](#) concluded, "Given the role of creativity in everything from health to education to innovation, the lack of support is a serious matter—and that is a serious understatement" (p. 109).

Conclusion

Creativity is an invaluable human resource that can enhance the quality of life. Although the field of creativity initially investigated individual creativity, in the last two decades both individual and team creativity have been about equally important.

The role of government in nurturing and supporting creativity begins with k-12 education. Another means in which government can invest in creativity is to support creativity research, make connections between theory and practice, create national plans and initiatives that support creativity at different levels of government, and setting up policies that support creativity. For example, the Canadian government, which established 'Creative Canada: Policy Framework' in 2017, Innovative UK 2015–19 Strategy, and the United Arab Emirates National Innovation Strategy.

This entry concludes with a suggested definition of a creative government: the creative government consists of an administration which values creativity, and thus, (a) invests in creative potential starting from k-12 education, (b) supports individuals transforming their creative ideas to tangible products (i.e., inventions) that are both novel and useful, (c) supplies funds for creativity research and practice, and (d) attracts talented individuals from other part of the world by offering an ideal environment for investments.

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- National Research Foundation Singapore: (<https://www.nrf.gov.sg>)
- National Science Foundation (<https://www.nsf.gov>)

Group Creativity

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Group Creativity

Despite the persistent and often-cited stereotype of the ‘lone genius’, much creative work actually takes place in groups, teams, or other collaborative settings. This is especially true in organizations, where an increasing amount of work is organized in permanent or temporary teams (such as production teams, project teams, quality circles, etc.). It is also true in art (music, especially), science, sports, and any setting where something is to be gained by having multiple people work on a task together. Whereas creativity is usually defined as the generation of ideas that are both novel and useful, group creativity occurs when these creative ideas are the result of several people working together.

Properly organized, group work increases the amount of work that can be done, the amount of resources that can be drawn upon, and the efficiency with which it can be done. In terms of creativity, group work primarily means that creativity could benefit from the presence of a broader variety of knowledge, abilities, and traits. Furthermore, when group members are exposed to various inputs from other members, their creativity may be stimulated. Thus, group work can *stimulate* creativity to the extent that groups and their members manage to make use of (i.e., exchange and process) the information and perspectives available. In contrast, group creativity is *hindered* by factors that prevent groups from being creative either because information or ideas do not get shared or because they do not get processed and used within the group.

It should be noted that group creativity is not simply an aggregate of multiple individuals’ creative behavior. Groups are *multilevel entities*, meaning that their performance as well as the influences on that performance can exist on multiple levels. Thus, group creativity may depend on certain factors at the individual level (e.g., individual traits and abilities, individual contributions to the group) and the group level (e.g., group size and structure, characteristics of the group task, group processes and performance). It will also depend on factors at even higher levels of analysis, such as the organizational (e.g., organizational culture or mission, reward structures) or even the societal level (e.g., social norms, national culture, economic circumstances). Further, variables on higher levels will feed into lower-level variables (as well as vice versa): The individual creative behaviors of group members will be influenced by group-level variables such as task structure, group size, and group climate. For example, people working in a large group, where individual members’ contributions are not identifiable, may be tempted to free-ride on their fellow members’ efforts and contribute less than they could have. The group-level effect (i.e., the temptation to free ride as a consequence of identifiability) may exist for all members, but the strength of the effect may depend on individual differences (e.g., on an individual’s identification with the group). Thus, a thorough understanding of group creativity requires a multilevel perspective, recognizing that groups are more (or less) than the sum of their parts.

Building on this conceptualization, the remainder of this contribution will discuss two broad topics. First the evidence about creative performance in groups will be summarized, and then ways to make groups more creative will be discussed.

Creative Performance in Groups

Although creativity is not a linear process, many theorists and researchers adopt some sort of stage model of creativity, for example moving from problem definition to idea generation, via idea evaluation and selection, to idea implementation. In

the context of group creativity, research has primarily focused on idea generation, but research is increasingly beginning to study the later 'stages' of the creative process in groups.

Idea Generation

Many people will associate idea generation in groups with brainstorming sessions. The word brainstorming (using the brain to "storm" a problem) was coined by advertising executive Alex Osborn in his 1953 book *Applied imagination* (Osborn, 1953). He proposed that group idea generation would be stimulated when idea generation and idea evaluation are strictly separated: When judgment is deferred to a later moment, people do not fear evaluation and criticism and are more likely to share their wildest (and potentially most creative) ideas. Further, Osborn suggested that emphasis during idea generation should not be on idea quantity, because the more ideas that are generated, the more likely that some of them will be good. He converted these two principles, "deferment of judgment" and "quantity breeds quality," into four brainstorming rules: Quantity is wanted; freewheeling is welcomed; do not criticize ideas; and build on and combine previous ideas. Osborn also originally suggested that, when these four rules are followed, people would be more creative when they work in groups rather than alone, because group members may stimulate additional ideas from each other.

Brainstorming has since become one of the most used creative techniques. For example, the word "brainstorming" yields more than 75 million hits in a Google search (January 2019), of which almost 50,000 give advice on how to brainstorm more effectively (at least, they contain the phrase "effective brainstorming"). Moreover, the brainstorming technique has generated a considerable amount of research, allowing for a number of robust conclusions (see Stroebe et al., 2010, for an overview).

There is evidence that generating more ideas is associated with generating more good ideas, with "good ideas" defined as those that are both original and useful. However, sheer productivity (i.e., number of ideas, often also called idea fluency) usually is not related to the *average* quality of ideas. It is thus the case that generating more ideas implies generating more good ones, but also more bad ones (i.e., those relatively low on originality, usefulness or both). However, there is less clarity about the rule of not criticizing ideas. On the one hand, evidence suggests that a group climate in which ideas are shared openly without fear of criticism or ridicule – a psychologically safe team climate – is beneficial for creativity. On the other hand, some evidence suggests that (mild) conflict and dissent during idea generation can be beneficial as well. Conflict, however, only has these beneficial effects when it is constructive rather than personal and when the team climate is safe (see discussion below).

Most research has considered the question whether brainstorming in groups is more effective than brainstorming alone. When this question is asked to the general public, it appears that people across cultures (e.g., North America, Western Europe, Japan) share the belief that group brainstorming is more effective than individual brainstorming. However, when actually tested in research, this belief proved to be false: People actually generate more ideas and more good ideas when they brainstorm alone than when they brainstorm in groups. This is a robust finding and is usually referred to as the "productivity loss" of brainstorming groups.

Because this finding comes as a surprise to many, it is important to understand the methodology used in these studies. In particular, these studies compare the production of a (real, interacting) group of N people (say a five person group) with the production of so called "nominal groups" consisting of N people (e.g., five individuals) who work alone for the same amount of time ("equal person-hours comparisons"). After the brainstorming session, the production of these individuals is pooled, and duplicate ideas removed. The idea is that the performance of nominal groups should be a good estimate of group performance if interacting with others in a real, interacting group neither facilitates nor hinders individual idea generation. Research thus concluded that interacting in a group did not stimulate members' creativity, but rather inhibited it.

Research indicated that the effect may be partly due to lack of effort: People who work in groups may work less hard than individuals, who cannot "hide in the crowd." There is also some evidence that, despite the instruction not to criticize ideas, people are still somewhat reluctant to share all their ideas in a group (because of the fear of negative evaluation, often called "evaluation apprehension"), and that this is especially true for shy people. The most important cause, however, is *production blocking*. This refers to the fact that in groups usually only one person talks at the same time. This means that group members have to take turns to express their ideas and can only express them when no one is talking, which blocks their ability to produce ideas. Production blocking implies that group members often have to wait for their turn, and this has been shown to interfere with their ability to generate ideas.

Interestingly, if production blocking is an important cause of the productivity loss of brainstorming groups, this implies that the productivity loss should disappear if turn-taking is eliminated. This is exactly what was found when procedures were used that did not require turn-taking among group members, such as exchanging ideas through computers (electronic brainstorming; people can type simultaneously and read ideas of others on the screen) or through written notes (brainwriting; people pass on written notes to others but can write at the same time). In fact, there is evidence that sharing ideas is actually stimulating in electronic brainstorming and brainwriting groups, leading to ideas that people probably would not have generated.

Recent studies also looked at the degree to which group members followed the fourth brainstorming rule regarding combining and building on previous ideas (Kohn et al., 2011). Groups whose members actively followed the rule outperformed groups that didn't. Thus, cognitive stimulation in groups could happen either because hearing (or reading) somebody else's idea activates domain knowledge in long-term memory and hence leads to new ideas, or because group members actively try to build upon and extend the raw materials provided by other group members' ideas.

Another area of group work where cognitive stimulation (rather than productivity losses) is central, is *group improvisation* (e.g., in music or improvisational theatre; e.g., Sawyer, 2007). While a brainstorming session revolves around generating as many ideas as

possible, which is difficult to reconcile with group interaction (e.g., with the rule that only one person speaks at a particular time), other creative group tasks are more about collectively creating something by continually building upon each other's contributions. Thus, a jazz trio is (hopefully) not trying to produce as many new musical phrases as possible, but rather to use the group interaction to come to something new and valuable within a certain framework. However, probably due to difficulties in data collection and analysis in such naturalistic and spontaneous group interactions, most research on group creativity has focused on idea generation in brainstorming or similar tasks.

To summarize, the brainstorming literature suggests that brainstorming in the traditional way – sitting around a table and expressing ideas aloud – is not very effective. More successful methods include electronic brainstorming and brainwriting, exchanging ideas with others which can be stimulating. Stimulation may occur both as a consequence of exposure to others' ideas, or when people build on one another's ideas (e.g., during improvisation).

It should be noted that organizations may use group brainstorming sessions for other reasons than mere productivity (Sutton and Hargadon, 1996). For example, group brainstorming sessions are also thought to be useful to expose employees to a variety of ideas, possibly learning new things in the process, to stimulate transactive memory in the team or organization (i.e., 'knowing who knows what'), to act as a team-building intervention (e.g., because they can be a lot of fun to do and group members are able to contribute whatever they want), and to be a useful marketing tool towards (potential) clients. Thus, there may be other reasons to use brainstorming groups that are not necessarily invalidated by productivity losses.

Beyond Idea Generation

Although most research on group creativity has focused on idea generation, this is rarely the end of the creative process: additional steps include *recognizing* the most creative, valuable, or promising options, *refining* or *developing* ideas in order to satisfy different constraints, *selecting* ideas that actually deserve to be implemented, *promoting* ideas to stakeholders in order to gain the necessary resources, and of course *implementing* an idea into something that can actually be used or sold. All these activities can take place in a group setting; in fact, the closer one gets to implementation, the more likely coworkers, managers and possible clients are to get involved.

It has also been argued that these later stages of the creative process, such as idea evaluation and idea selection, are the ones where group work is more likely to be effective than individual work. Groups outperform individuals on so-called *intellective tasks*, where the search is not for ideas but for a demonstrably correct solution. In these *disjunctive group tasks*, only one member needs to find the correct answer for the whole group to succeed. Unless there is something about the group process that hinders members in searching for a solution (e.g., production blocking in idea generation) or sharing the solution with the group (e.g., evaluation apprehension, lack of safety), groups will generally outperform individuals on these tasks, simply because the probability of at least one of the group members finding the solution will be higher than the probability of a single member finding the solution. This may happen in so-called *insight problems*; there, the correct solution is usually recognized to be correct once it has been produced, and indeed groups do seem to outperform individuals on such tasks. However, creative problem solving is not an intellective, but a judgmental task; that is, there often is no clear 'correct' answer or solution. Consequently, the best idea is not automatically recognized when it is proposed.

Idea Selection

Research indicates that groups do not perform very well in selecting creative ideas (e.g., after a brainstorming session). Experiments on idea selection after group brainstorming consistently found that groups seriously underperform in terms of selecting their best or most creative ideas, sometimes even failing to perform above chance level: In several studies, the ideas that groups selected did not differ in quality from the average of their ideas. They seemed to prefer high feasibility over high originality. Thus, creative potential generated during brainstorming gets lost during idea selection. This is especially problematic in light of the fact that many interventions and techniques (such as brainstorming) seem to focus on getting groups to generate more ideas. Research on idea selection suggests that this can be a serious waste of time and money, since these ideas are likely to get lost in selection anyway.

Similar results have been found on the individual level, suggesting that this is not exclusively a group problem, but also reflects something about the way people respond to creative ideas. Because creative ideas are risky and unpredictable, they can cause uncertainty and can lead people to avoid them and to favor more familiar options that are known to be feasible. However, this may well be exacerbated by the group context: Considering that the selection of creative ideas is a judgmental task that typically is done through a 'majority wins' decision rule, and that biases present among individuals tend to become more influential under 'majority wins', the individual bias against originality may become even stronger in a group context. In contrast, as explained above, if idea selection were intellective (that is, a matter of finding a demonstrably 'best' option), group interaction should enhance performance (because the chance of at least one group member finding the best idea would be higher). The difficulty of selecting creative ideas, then, lies in the uncertain and unpredictable nature of highly original ideas, and this is also what makes it especially difficult for groups.

Idea Development

Raw ideas are rarely ready to be selected (or rejected) for implementation: Usually an idea will need to be refined, improved, elaborated, and/or adapted to the constraints of reality before selection and implementation can take place. Like idea generation, idea

development, or the process of refining and improving ideas, can be done by individuals, but is often likely to happen collaboratively. Idea development processes do seem to contribute to groups' idea generation and selection performance, suggesting that idea development is not necessarily an intermediate stage on the road towards selection, but can in itself lead to cognitive stimulation effects (or even to redefinition of the problem), and hence to new ideas (e.g., [McMahon et al., 2016](#)) (See Problem Finding).

An additional possibility is that idea development opens the door for better idea selection, because it allows one to improve an idea in order to have it satisfy multiple criteria (e.g., high originality *and* high feasibility). Thus, if an idea has appeal because of its high originality but seems unfeasible, rather than rejecting it out of hand, the idea could be refined or revised to make it more practical or easier to implement, while retaining the novel aspects of the idea. Although idea development discussions in groups have also been found to revolve strongly around feasibility (similarly to what happens in idea selection), groups should be especially suited for idea development if they bring their diverse cognitive resources to bear on the discussion (See Problem Solving).

Idea Implementation

The goal of idea generation, development, and selection is to turn ideas into actual products or procedures that can be sold or used – that is, idea implementation. Idea implementation is usually considered the end of the 'idea journey', where creativity turns into innovation. In reality, of course, even idea implementation can give rise to new ideas or further idea development: Whatever occurs or fails to occur as a consequence of idea implementation can be the starting point for a new creative process.

Problematically, idea implementation appears to be predicted by other variables than idea generation. For example, whereas external pressures decrease group (or team) creativity, they may contribute to successful implementation. Thus, what helps (or hinders) groups in their idea generation is not necessarily what helps (or hinders) them in implementing their ideas. Since the focus of (group) creativity research has largely been on idea generation, relatively little is known about the factors that predict successful implementation, but effective decision-making (i.e., idea selection) is an inevitable precondition. Because of the problematic nature of idea selection, the transition from creativity to innovation (that is, from idea generation to idea implementation) appears to be particularly challenging. Research on group and team innovation has predominantly aggregated innovative performance in measures that confound idea generation and idea implementation, but to the extent that these factors have been separated, group, team, or other social processes seem to be essential facilitators in moving towards successful implementation ([Somech and Drach-Zahavy, 2013](#)).

On the whole, then, although groups have undeniable creative potential, they often fail to live up to it. To a large extent, this seems to be due to their failure to make use of their cognitive resources. Ideas, perspectives, and opinions often do not get shared and processed effectively and efficiently. As such, the group creativity literature aligns well with the broader literature on group performance and group decision-making. For example, during decision-making tasks groups often discuss only knowledge that is already available to all group members, even if discussing unshared or unique information would demonstrably lead to a better decision. The discussion of task-relevant information, furthermore, can be superficial, and groups often fail to find optimal outcomes (such as integrative solutions in negotiations) even if all relevant information is available to all group members. Groups also often focus on reaching (and maintaining) consensus rather than on making the best possible decision, and often reject divergent information or viewpoints that threaten this consensus (especially when working under time pressure). Moreover, group polarization can lead to groups adopting an unnecessarily extreme viewpoint, which is not warranted by the opinions or knowledge of the individual members.

Nevertheless, despite the plethora of pitfalls that groups can fall into, the enduring popularity of group- and teamwork suggests that group creativity, for better or worse, is here to stay. The following section will discuss some general issues of how to organize creative group work effectively.

Designing Groups for Creativity

The literature on groups and teams is sometimes organized according to an Input-Process-Output framework, where Outputs are those variables that describe group or team performance – in this case, creativity. Input variables are those variables that describe what is 'given' about the group, such as group composition, group size, and characteristics of the group task. Process variables describe the things that go on in the group, such as communication, conflict and cohesion, and group climate and norms. Below, we discuss several Input and Process variables that affect group creativity.

Group Composition and Diversity

Obviously, group creativity benefits from having members with sufficient creativity-conducive traits and abilities. Personality, domain knowledge, creative skills, and motivation all contribute to each member's creative performance and hence might be expected to contribute to that of the group. This seems to be true to a large extent, although research also suggests that there is value in having (some) less creative group members (for example because these may be better equipped to safeguard a cooperative and systematic group process). Moreover, larger groups are not always more creative than smaller ones, even though a larger group should, all other things being equal, have a higher probability of containing at least some members with highly valuable knowledge, traits, or skills. For example, larger groups seem to be more susceptible to social loafing (where group members contribute less to the

group than they could, because their individual contributions are not identifiable and are perceived to be dispensable). Then again, larger groups potentially harbor a greater *variety* of knowledge, traits, and skills. Thus, beside the mere presence of certain member characteristics in the group, the way they are distributed and arranged in the group is a crucial aspect of group functioning as well.

However, group diversity actually is a double-edged sword: On the one hand, it is one of the reasons for using groups to begin with, but on the other hand groups often find it difficult to deal with. As a consequence, the effects of diversity on group creativity are inconsistent. Surface-level or demographic diversity (e.g., gender, ethnic, or age diversity) in particular can easily give rise to subgroup formation and, as a consequence, ineffective communication and information sharing within groups. Deep-level or cognitive diversity (which may or may not be aligned with surface-level diversity), on the other hand, is where groups' creative potential originates, but when left to their own devices groups usually fail to make use of this resource. Given that creativity, including creative decision-making, requires the integration and combination of diverse information, this obviously hampers groups' creative performance.

Whether or not groups are able to make use of their diversity depends on several factors, such as the diversity beliefs that group members hold: If group members have a strong belief that diversity is a valuable resource (rather than, say, a threat or a complication), diverse groups may perform more creatively than homogeneous groups, because they will be more willing to exchange and process diverse information and perspectives. Generally speaking, (cognitive) diversity *can* stimulate group creativity, if the group members are able and motivated to exchange and process their diverse (task-relevant) knowledge and ideas. However, field research also suggests that team diversity, although it can indeed stimulate creativity, does not automatically lead to successful implementation of the generated ideas.

Of course, group composition is not necessarily a given. Groups and teams change over time. This may also affect group creativity: For example, *newcomers* can bring previously unavailable knowledge or perspectives to the group. Some work suggests that such membership changes can indeed bring about or stimulate group creativity, but this depends on several boundary conditions including the characteristics of the newcomer, the stability of group membership, and group climate. Similarly to other forms of minority influence, a newcomer's ideas are not automatically attended to or valued by the rest of the team, but there is the potential for a newcomer to make a novel contribution that would not have been made otherwise.

Task Design and Interdependence

Besides selecting the right people for the group, for example those high in creativity or those contributing relevant and unique skills and insights, a fundamental way to enhance group creativity is through task design. A first, and relatively obvious principle is that the member resources (that follow from group composition) must be sufficient to match task requirements. If this is not the case, and important skills and knowledge are missing, it follows that either group composition must be changed or the task must be adjusted.

Secondly, at the individual level, the job characteristics model suggests that optimal task design includes 1) providing employees with sufficient autonomy, so they feel responsible for their job; 2) providing them with constructive feedback, so they know how well they are doing; and 3) giving them tasks that require varied skills, that are important to them, and that require the completion of a whole task (rather than only a part of it), so employees experience their work as meaningful. It is likely that these conditions will not only enhance work motivation and effectiveness of individual employees, but also of groups. For example, many organizations grant much autonomy to their teams, and research confirms that creativity and innovation are more likely to thrive in such relatively flat (as compared to more hierarchically structured) companies.

Thirdly, when it comes to team design, another critical task design feature is interdependence. Research distinguishes two types of interdependence. *Task interdependence* refers to the degree to which work is designed in such a way that members depend on each other for access to resources (e.g., information) and for coordinated action. *Outcome interdependence* refers to the degree to which outcomes of tasks are measured, rewarded and communicated at the group (rather than the individual) level. Research suggests that task interdependence creates a *need* for group members to cooperate, whereas outcome interdependence creates the *motivation* to do so. Because cooperation is crucial for groups to achieve high creativity, these two types of interdependence are extremely important.

Importantly, task and outcome interdependence are not necessarily aligned. It is possible, and relatively common, that group members have high task interdependence, but that feedback and rewards (e.g., promotion opportunities) are given to individuals and not the team. This is potentially problematic, because it creates a situation in which people have to collaborate, but may lack sufficient motivation to do so. Similarly, a combination of high outcome and low task interdependence creates problems, because people may have the motivation to work together but lack control over outcomes. Good task design thus requires that both types of interdependence are aligned. Following the principle that high group creativity requires an optimal combination of contributions of individual members, the alignment of high task and high outcome interdependence will stimulate cooperation and make it more likely that resources of the team members are used in an optimal way.

Group/Team Climate

Although properties of the group (e.g., composition) and the group task (e.g., interdependence) are important, some of the strongest influences on group creativity are found in the group process. These group or team processes, especially in organizations, are often described as *climate*, which is a shared set of norms and expectations regarding the way a team works. Climate factors are among the strongest predictors of group/team innovation, and the transition from idea generation to idea implementation crucially

depends on climate. Much of this work has used the Team Climate for Innovation model, which identifies four climate dimensions that contribute to group or team creativity and innovation (Anderson and West, 1996). Groups and teams perform more creatively and innovatively if they work towards a shared and valued goal, if new input and divergent opinions are welcomed, if innovative performance is the goal and the norm, and if the group is striving for excellent (innovative) performance.

Of these process or climate variables, *safety* – the degree to which members feel that their input is welcome – is particularly interesting, because its role is paradoxical. On the one hand, a safe group climate means that members can contribute without fear of negative evaluations or ridicule. A lack of self-censorship is a crucial precondition for creativity (and was one of the reasons Alex Osborn devised his classic brainstorming method). Thus, a certain sense of safety, group cohesion, or cooperation (as opposed to intragroup competition) is important. On the other hand, if safety and cohesion become dominant concerns, this could lead to group members holding back ideas or opinions that might cause conflict or dissent (in extreme cases, this could lead to forms of groupthink). This is particularly important in the context of group creativity, because novel ideas require a jump into the unknown and therefore are associated with uncertainty. In fact, organizational research suggests that employees who contribute and push for implementation of creative ideas are likely to experience more conflict with colleagues, because these creative ideas challenge the status quo.

A curvilinear relation between safety, creativity and innovation has been hypothesized, suggesting some optimal level of safety that is neither too low nor too high (Hülshager et al., 2009). Research suggested that groups perform most creatively when there is a mix of individualism (stimulating group members to develop their own, unique perspectives and ideas) and collectivism (motivating group members to contribute these perspectives and ideas for the benefit of the group). This tension between individualistic and collectivistic tendencies was addressed in a study which showed that minority influence (e.g., one group member disagreeing with the rest) can force the group to think about and discuss the task or task-relevant information more deeply (although this may require a high degree of participative decision-making), and may enhance divergent thought within the group. Moderate levels of task conflict may also contribute to group creativity or innovation, again because these can stimulate groups to engage in deeper information processing and more divergent thought – as long as the task conflict does not escalate and spill over into relationship conflict. Thus, creativity seems to require a group climate that is safe and cooperative enough for the individual member to challenge group members views and risk some conflict once in a while.

Other research that looked at different climate variables suggests that organizational teams perform more creatively when they have a strong promotion climate (i.e., focused on growth, attaining successes, and realizing ambitions) as opposed to a prevention climate (focused on safety, avoiding mistakes, and fulfilling responsibilities). Other group process variables that can affect creativity include reflexivity (the degree to which the group reflects on its own goals and strategies), communication both within and outside of the group or team, and conformity pressure resulting from a high need for closure (e.g., as a consequence of time pressure). If the group is strongly focused on making a quick decision, new information or divergent opinions are not welcome and will probably not get processed deeply.

Leadership

Finally, a great deal of research has considered leadership as an important determinant of group creativity. Even though organizations sometimes use leaderless teams (e.g., self-managed teams), most still include some form of leadership. Because leadership implies that those holding a leadership position have more power and influence than those who do not, characteristics and actions of leaders will have a disproportionate effect on creativity of the team.

There are two broad approaches to how leadership affects creativity in groups. The first looks at leadership styles. Most attention has been given to transformational leadership, which refers to a leadership style consisting of a combination of having an appealing vision for the group (e.g., be charismatic) and intellectual stimulation and taking care of group members. Not surprisingly, this leadership style will generally benefit group creativity, because it solicits the input of group members and unites them to try to achieve something great together. For example, it has been found that teams with transformational leaders are better able to reap the benefits of team conflict. A downside of this type of leadership is that it makes group members fairly dependent on the leader.

The second approach proposes that the task of leaders is to create the conditions for groups to be creative. In line with the discussion of designing creative groups, this approach suggests that leaders have to 1) make sure that they have the right people in the group; 2) create the right task conditions (e.g., interdependence structure); 3) create the right group climate (e.g., one in which members feel safe to express their unique insights). Other functions that leaders need to fulfill are ensuring that the group has sufficient resources, and monitoring progress and providing feedback to the group. This approach suggests that groups can be made more creative if leaders create the conditions under which group members can “do their thing” in an optimal way.

Conclusion

Groups have undeniable creative potential: The presence of a large and diverse store of knowledge, experiences, personalities and opinions can, in principle, make them extremely powerful sources of creativity. Whether or not groups live up to this potential crucially depends on the way they organize their work. When left to their own devices, it is all too easy for groups to fall into one of the myriad pitfalls associated with group work. However, under the right circumstances, including high levels

of task-relevant cognitive diversity coupled with effective leadership, favorable diversity beliefs and membership, moderate levels of task conflict, a strong motivation to process task-relevant information and a healthy mix of individualistic and collectivistic motives, groups have a lot to offer.

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Health

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Glossary

Bipolar mood disorders A group of related mood disorders described in the American Psychiatric Association’s *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition, (DSM-V) (2013). These can be serious, but they are also often effectively treated. Bipolar disorders are characterized by the presence of an episode of unusually elevated mood, but they typically also involve episodes of depression; these episodes of high and low mood frequently alternate with periods of normal mood. Several types of bipolar mood disorders can be distinguished. A strong familial liability to bipolar disorder is manifested in a wide range of psychiatric syndromes, from mild to severe.

Compensatory advantage In biology, there are examples of genes that increase vulnerability to illness but are also tied to positive characteristics. An example is sickle cell anemia, in which individuals who inherit a copy of the same mutant gene from both parents experience serious medical complications. In contrast, individuals who inherit only one copy of the mutant gene have milder symptoms and an important compensatory advantage: resistance to malaria. Several studies suggest that enhanced creative potential may be a compensatory advantage for genetic liability to schizophrenia and bipolar disorder.

Depression and unipolar mood disorders Unipolar disorders are characterized primarily by periods of unusually low mood, usually alternating with periods of relatively normal mood. Adverse effects of depressed mood on other psychological functions are also typically present, such as disturbances in sleep, appetite, and energy. These mood disorders can range from major or severe depressions to milder ones. These disorders can be extremely serious, but effective treatments are often available.

Schizophrenia spectrum disorders Schizophrenia is a psychotic disorder characterized by periods with two or more of several key symptoms: delusions, hallucinations, disorganized speech or behavior, and negative symptoms, such as diminished emotional expression and initiative. These symptoms also cause significant dysfunction in areas such as work and

interpersonal relations. Biological relatives of schizophrenia patients also tend to have higher rates of milder disorders and schizotypal symptoms such as odd ideas and unusual perceptual experiences.

Introduction

This chapter discusses research findings on several of the many ways that creativity and health influence each other. Research indicates that creative activities, therapies, discoveries, and problem-solving are important for understanding, treating, and preventing medical disorders. But while creativity is important for improving mental and physical health, so too is health important for fostering creativity (Richards, 2014; Kinney and Richards, 2014).

We will focus on four particularly important sets of questions about how health and creativity interact. First, can creative activities and therapies improve negative moods and clinical depression? This is important because *major depression is an especially serious health problem*: depression is a major risk factor in suicide, and many medical disorders. The WHO estimates that major depression is also the leading cause of disability in the peak years of working and caring for families.

Second, how are health and certain mental illnesses related to creativity? Is creative genius more common in people with mood and schizophrenia-related disorders – and if so, why? Do genes that increase liability for these disorders also increase creative potential?

Third, how can we encourage creative problem solving that leads to new medical discoveries? It's a crucial question, because medical breakthroughs are crucial for improving health of people with *many different* physical and mental disorders.

Fourth, can research on creative problem-solving and negotiation unite diverse people to find win-win solutions for the most threatening global health problems – such as infectious disease pandemics, and mass extinction of species – that would severely damage health of both people and animals for many generations?

Can Creative Activities and Therapies Improve Mood as Well as Mental and Physical Health?

Several lines of research provide evidence that engaging in creative activities can help raise people's mood and combat depression. For example, Silvia et al. (2014) studied young adults' activities and feelings at randomly sampled times over the course of a week. The researchers found that when people were doing creative activities such as writing or drawing, they reported feeling happier on average. This study was correlational, however, so it is difficult to be certain about causal relations between creativity and mood. Other studies have used *experimental* research designs, where one can be more confident about *causation*.

Ellen Winner and colleagues conducted several such experimental studies on how creative activity affected temporarily depressed mood in healthy children or college students. They found that students' mood was more likely to improve if they were assigned to engage in certain types of creative activity. For example, DePetrillo and Winner (2005) found that being asked to do creative artwork elevated in depressed mood in students whose sad mood was induced by watching distressing videos.

Another experiment tested whether *art therapy* improved mood in depressed patients (Blomdahl et al., 2018). In addition to standard treatment, patients were assigned at random to receive, or not receive, manual-based art therapy that asked individuals to paint pictures based on their personal goals. Patients who received art therapy had significantly greater reduction in depression than controls without art therapy. These promising findings need to be confirmed in new studies.

Complementary research suggests creative therapies could also improve *physical health*, because multiple studies found that depression is associated with increased risk for many serious medical disorders such as heart disease and diabetes. Niles and O'Donovan (2019) analyzed longitudinal data on more than 15,000 older adults, finding that depression increased risk illness as strongly as, or even more strongly than, obesity and smoking.

Depression also tends to induce depression in depressed patients' *relatives*. For example, if mothers are suffering from postpartum depression, their infants are also more likely to become depressed; treating depressed mothers also relieves children's depression. Bipolar disorders and schizophrenia are also associated with increased rates of suicide and certain medical disorders. Creative therapies might therefore help many different mental and physical disorders.

Is Creativity Related to Certain Mental Disorders and Genetic Liability for These Disorders?

Overview

Are genius and madness related? Many scientific studies have found evidence for significant relations between creativity and mental illness and/or genetic liability for certain mental disorders. The strongest associations with creativity involve bipolar disorders and schizophrenia – and genes for those disorders. Highest average creativity is found, *not* in individuals with severe

symptoms, but rather in their *healthier relatives* who may carry genes for these disorders. These genes in turn may be associated with unconventional ways of perceiving and thinking about the world – ways that help generate novel ideas that lead to creative breakthroughs.

Research on creativity and *mood* disorders, including bipolar disorders and depression, is discussed in more detail in the chapter on **Bipolar Disorders** in this encyclopedia. We therefore will consider key points on those disorders rather briefly here, before turning to a longer discussion of creativity and schizophrenia spectrum disorders.

Creativity and Mood Disorders

Several studies of eminent creators in art, literature, and music found higher rates of mood disorders among these creators (e.g., Jamison, 1989). Further research indicates this is *not* the result of beneficial effects of extreme moods on creativity. Rather, eminent creators report their *most creative* periods are associated with episodes of mild or moderate mood elevation; extreme moods such as mania and major depression actually interfere with creativity. Complementary evidence found that, on average, the greatest creativity in people's job and hobbies is found in the *healthier* biological relatives of people with bipolar disorder, rather than either people with frank bipolar disorder, or people with no personal or family history of mood disorders (e.g., Richards et al., 1988; Kyaga et al., 2011).

Schizophrenia and Schizotypal Symptoms

Research on the relation of creativity to schizophrenia and milder “schizophrenia spectrum” disorders found parallel results: symptoms of full-blown schizophrenia – such as hallucinations and delusions, or deficits in thinking, attention, and initiative – are associated with *lower* creativity. By contrast, *healthier* biological relatives of schizophrenia patients tend to have *more* creative job and hobbies than people with no personal or family history of mental disorders (e.g., Kyaga et al., 2011). Similarly, individuals with schizotypal personality disorder or schizotypal signs – unusual types of thinking and perception more common in biological relatives of schizophrenia patients – tend to report more creative jobs and hobbies than control subjects (e.g., Kinney et al., 2001), and score higher on creative thinking tests (Folley and Park, 2005).

Other studies found that certain genes that increase risk for developing schizophrenia or psychosis also are associated with increased creativity in individuals who carry the genes but don't develop frank schizophrenia (Keller and Visscher, 2015). This increased creative potential may be a “compensatory advantage” for the genes, which helps explain why the genes – and severe disorders they may help produce – persist in the population, despite the fact that people with schizophrenia are less likely to have children (Kinney and Richards, 2014).

Creative Problem Solving, Unconventional Ideas, and Revolutionary Advances in Healthcare

We will now shift to *different* ways in which creativity can have important effects on health. *Generating creative ideas* is crucial for *discovering new ways to understand, treat, and prevent diseases*. This process works best when curiosity and openness to considering – and testing – new ideas. A paradox in scientific discovery is that the most important new ideas are often ones that challenge conventional thinking – and that therefore often initially receive severe criticism – even ridicule. Let's consider two important examples in medicine.

Australian physician Barry Wallace shared a Nobel prize for discovering that many peptic ulcers are caused by an infection with the bacterium, *H. pylori*. Ulcer specialists initially dismissed Wallace's theory, because conventional wisdom held that stress caused ulcers and bacteria could not survive the stomach's acidic environment. Wallace persisted, showing that *H. pylori* thrives in acidic conditions, and antibiotics that killed *H. pylori* often cured ulcers.

A second example illustrates how creative breakthroughs – because they often involve radically new ways of thinking about health problems – sometimes come from people outside a medical field. A revolutionary device for more safely delivering babies was invented, not by obstetricians, but Argentine auto mechanic, Jorge Odon. Odon's device is potentially the most promising advance in decades for treating obstructed labors that kill thousands of infants and mothers each year.

Note, however, that most unconventional ideas don't work. Developing a theory or invention typically requires winnowing good ideas from bad ones, and extensive testing and modification until a good working model is reached. Uncritical acceptance of unconventional ideas can be dangerous. For example, epidemiologists concluded that over 300,000 South Africans died from AIDS because one president, Thabo Mbeki, believed a discredited theory that HIV didn't cause AIDS, so he blocked lifesaving programs that use antiviral medications to treat HIV (Chigwerdere et al., 2008).

Creative “Win-Win” Solutions to Successful Negotiation and Breakthroughs in Healthcare Advances

Research on Steps in Creative Problem-Solving and Successful Negotiation That Lead to Win-Win Outcomes

Some of the most important advances in healthcare involve the development of creative “win-win” policies and programs that simultaneously advance the key interests of groups with different agendas. Decades of research on negotiation by Harvard Law

professor Roger Fisher and his colleagues identified several key steps in achieving the ideal outcomes that leave both parties a) believing their key goals have been significantly advanced and b) having positive feelings for each other.

A key step is actively searching for these creative win-win solutions that help advance key interests of *both* parties. To find these win-win solutions involves entering the negotiation with an open mind about possible solutions – a key point, because the research found the *best outcomes* were usually *creative ones* that never occurred to either party before the negotiation began.

Let's now consider two examples of how creative problem solving and negotiation – and the search for win-win solutions – can be key factors in reaching the best outcomes for the world's most important health problems. Win-win outcomes from creative negotiation can be even more important than creative discoveries of cures for a single illness, because a win-win outcome can simultaneously help solve not just one, but *many different medical problems*.

Better Prenatal Care: A Win-Win Strategy to Save Lives, Improve Children's Long-Term Health, and Prevent Unnecessary Healthcare Costs

A long-standing debate – particularly heated in the US – involves how much governments should spend to ensure that all their citizens receive good quality healthcare. One view is that providing high-quality healthcare is of prime concern. A competing view is that curbing increasing healthcare costs is more important.

A win-win strategy to help address this dilemma is indicated by scientific evidence that *quality prenatal health care* – such as pregnant women's access to good healthcare and nutrition, and protection against infections, chemical toxins, and maternal emotional stress, saves lives and money *in many different ways*. It reduces fetal, infant, and maternal death rates. In addition, analyses by economists Almond and Currie (2011) found that spending money on better prenatal care is a highly cost-effective way to promote people's mental and physical health. Improving prenatal care is cost-effective because the intervention period is relatively brief, and the better health outcomes for children can last a lifetime, reducing healthcare and social welfare costs for decades, and making people healthier and better able to work and contribute to economic health of society.

Protecting Endangered Species and Wilderness: Creative "Multi-win" Ways to Protect Human and Animal Health, Discover Breakthrough Drugs, and Prevent Infectious Disease Pandemics

An even more important kind of win-win approach could improve health a) not just of one country, but of people around the world, b) not just of people alive today, but of countless future generations of people, and c) not just of human beings, but of millions of animal species threatened with extinction. Nobel-Prize-winning physician Eric Chivian (2012), reviews evidence of the vital importance for *human health* of protecting animal species from extinction. Protecting these species is the best way to protect animals' rights, but mass extinction also threatens *people's* health. Other species have evolved the capacity to survive infections and other illnesses that kill millions of people. These species thus have medical secrets for how to treat and prevent human illnesses; if these animals go extinct, we will lose their secrets forever.

For example, *current antibiotic drugs* save millions of people's lives, but they eventually no longer work, because bacteria develop genetic resistance to the drugs. Yet some species of frogs produce antibiotics to which germs don't develop resistance. Understanding how frogs do this would save countless human lives. Opioid drugs provide critical pain relief, but they also can cause addiction, killing millions of people each year, and opioids can lose their pain-reducing power because patients develop tolerance to the drugs. Chivian notes the first drug with the pain-relieving potency of opioids, but without their addictive and tolerance problems, was derived from a toxin produced by predatory cone snails. These snails have evolved more than 100,000 specialized neurotoxins (to kill prey) that are more sensitive and targeted than drugs we now have. These neurotoxins may be the most valuable pharmacopeia on earth, but their medical secrets may soon be lost, because most cone snails live in coral reefs that climate change is beginning to kill.

Infectious disease pandemics such as AIDS and Ebola have killed millions of people. These epidemics began when humans contracted novel infectious agents from contact with wild animals in wilderness areas. These infections are often particularly deadly to humans because human populations lack previous exposure and have developed little genetic resistance to the infectious agents. One of the most *creative and effective* ways to protect present and future generations from new epidemics is protecting wilderness areas and wildlife from encroachment by people.

Optimistic Win-Win Implications of Research on Creativity and Mental Disorders

Research discussed earlier on creativity and liability for mental disorders has optimistic implications. Treating patients' symptoms is a win-win approach: a) helping patients and their relatives realize their unusual creative potential, while also b) helping to increase the self-esteem of patients and their relatives, and c) fighting the stigma often attached to the disorders. The world desperately needs more creative solutions to daunting problems – such as nuclear war and climate crises. The unusual potential for great creativity carried by many bipolar and schizophrenia patients – as well as their biological relatives – is a precious natural resource for developing creative solutions to these crucial problems. Therapists and educators – through appropriate medical and counseling support for these talented but vulnerable individuals with genetic liability for schizophrenia or mood disorders – may help realize that untapped creative potential, to the enormous benefit of the world, as well as the patients and their families.

Conclusion

We have discussed research on several of the most important issues involving creativity and health. Let us now review the key research findings that help answer the four sets of questions we posed at the beginning of the chapter.

Can Creative Activities and Therapies Help Combat Depression as Well as Other Serious Medical Disorders?

Evidence from several complementary lines of evidence indicates that creative activities and therapies can improve mood and fight depression. Experimental studies of college students, as well as a clinical trial with depressed patients, found that creative activities and art therapy respectively elevated mood. Complementary research suggests that creative therapies that lift mood could also prevent other disorders, because major depression increases risk for these disorders. More research is needed to confirm these findings.

Is Enhanced Creativity Related to Certain Mental Disorders or to Genetic Liability for These Disorders?

Research on this question suggests that the strongest associations of creativity with mental disorders involve bipolar disorders and schizophrenia – and genes for those disorders. Higher levels of creativity tend to be found, *not* in individuals with the most severe forms of these disorders, but rather in their *healthier relatives* who may carry certain vulnerability genes for these disorders. These genes in turn are associated with unconventional ways of perceiving and thinking that help generate unusual ideas that aid in developing creative breakthroughs. These results have *optimistic clinical implications*. For example, therapeutic support for people who carry these genes could prevent carriers from becoming ill and also help them realize unusual creative potential. These research findings also can help fight stigma and encourage patients to seek and maintain treatment.

How Do Unconventional Thinking and Creative Problem-Solving Help People Make Important Medical Discoveries?

Creative breakthroughs often come from people whose ideas so challenge conventional wisdom that they are initially treated with skepticism, as with the Nobel-Prize winner who discovered that a type of bacteria helps cause ulcers. Some breakthroughs even come from people *outside* a medical field, who can view problems from a fresh perspective, as with the auto mechanic who invented a potentially safer device to deliver infants. These findings have important *implications for aiding the discovery of new medical breakthroughs*, such as encouraging greater openness to testing theories that challenge conventional wisdom, and encouraging greater diversity of people in a medical field, because having people from diverse backgrounds often aids in generating creative new ideas.

How Can Creative, “Win-Win,” Ideas Help Solve Daunting Health-Care and Environmental Problems to Produce Revolutionary Advances in Global Health?

Creative problem-solving and negotiation among different people can lead to “win-win” solutions to some of most dangerous threats to global health. For example, protecting endangered species and wilderness areas can help prevent global infectious disease pandemics that have been some of the greatest causes of death in human history. This win-win approach can also protect millions of species from extinction and, in so doing, prevent us from losing the valuable medical secrets that those species can teach us, such as how to develop pain-killing drugs that are not addictive and to which people don’t develop tolerance. Such creative negotiating approaches to finding win-win solutions are also needed to solve other serious health problems, where different groups of people may have different values and priorities. Avoiding zero-sum thinking and searching for creative win-win solutions can help us overcome political deadlocks to solve many other challenging health problems.

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Relevant Website

<http://www.saybrook.edu/> – Support site for a graduate program on creativity. <https://www.bbrfoundation.org/> – Support site for information about bipolar disorder, depression, and schizophrenia.

Historical Conceptions of Creativity

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The way we conceptualize creativity today, as something both new and useful (Kaufman, 2016a), is the result of a long and complex history (Glăveanu and Kaufman, 2019). Understanding how our concept of creativity has developed over the ages is important for grasping the issues creativity researchers are facing today. One issue that will become apparent from this review is the historical focus on the creativity of men in Western civilizations. Another one is that although creativity research appears to be a ‘child’ of the 20th century, in particular its second half, the paradigmatic ways in which we understand creativity to this day have deep historical roots. It is important to note that we will focus mostly on the Western history of creativity. There are, undoubtedly, other histories of this phenomenon to be written, such as from an Eastern or a Global South perspective, and it would be interesting in the future to notice the commonalities, differences, and crossovers between these different cultural spaces when it comes to creating and creativity.

Biblical Times

During the biblical ages (and through the Middle Ages) all creativity was attributed to God (or gods, depending on the religion). According to the Bible, creativity was inextricably linked to the divine, because God created human beings and commanded their acts. Thus, all creation came directly from God, “The Creator”. Many early philosophers believed that it was not possible for a human being to create or experience anything new at all; Ecclesiastes (1:9), for example, claimed that there was “nothing new under the sun.” They considered all human activity to be an imitation of the divine and suggested that attempting to produce novelty only demonstrates our “vanity.” Similarly, in ancient Greece and Rome, creative acts were attributed to the gods or god-like beings. According to Plato, the Muses possessed poets in order to bring forth works that they could not achieve as mere humans. Aristotle suggested that all art was imitation of nature, created by the gods. Interestingly, thus, creativity did not originate for people living during Antiquity within the person but came from the outside, a conception that remains to this day in the way we sometimes conceive of inspiration. The concept of creation as inspired by and credited to God (or gods) continued into the Middle Ages and only came under scrutiny during the Renaissance.

The Renaissance

The Renaissance was a time of substantial invention and progress. It was during this time that it first became acceptable to attribute creativity to human beings. This was a revolutionary shift in the history of Western civilization – one that had long-lasting consequences not only for how we conceive of creativity, but also how we consider human agency and its relation to others and to society. During the Renaissance, men (and less so women, due to ideological reasons) started to place themselves at the origin of creativity, replacing God as the one and only creator. Interest for this kind of human creativity flourished. Artistic work was originally commissioned, for instance, by the church or by wealthy patrons. Over time, the visual arts were distinguished from crafts and technology, which were viewed as not originating from one’s creativity, and became allied with poetry as a creative art form. It was also during this time that artists began signing their artwork and independently creating (without the support of wealthy patrons) and selling their own work. Creativity in other areas, rather than just the arts, began to be recognized, such as in the sciences and invention.

The Enlightenment

The Enlightenment brought even further acceptance and encouragement of creativity, "... focused on change, the emergence of the new, through ordered progress, rather than through spontaneity" (Weiner, 2000, p. 71). European governments established incentives and awards for individual creators, and scientific and technological advances were plentiful (e.g., the steam engine, railroad, and gas lighting). Society began to grant rights to individuals regarding their creations, establishing patents and copyrights. It was during this time that the novel was invented, and the first museums opened. Defined by an ethos of conquering nature, including by constructing rational models of it, this period's view of creativity was that of an orderly process that could be explained causally, just like any other phenomenon. Although the Enlightenment was foremost characterized by the importance of order and rationality in creation, this ideal changed drastically during the Romanticism.

The Romantic Era

During the Romantic era, creativity came to be thought of as an innate ability, stemming from instinct and emotion, leaving little room for rational processes. As such, self-expression and imagination in the arts were highly valued. By the 19th century, genius as an individual attribute was largely thought to be hereditary. The idea of a link between genius/creativity and madness was widely popular at the time due to the fascination with the bizarre, the inexplicable, and the limits of human rationality (Becker, 2014). Attempting to separate from the past (i.e., the ideals of the Enlightenment) and distinguish themselves from the common man, the Romantics emphasized irrationality: "It was the aura of mania that endowed the genius with a mystical and inexplicable quality that differentiated him from the typical man, the bourgeois, the philistine, and the merely talented" (Becker, 2001, p. 48). The classic Romantic myth of Frankenstein emphasizes the genius of the creator and the madness brought by his own creation (once more, the focus at this time remained primarily on male creativity). Belief in a creativity-madness association is still common and is especially strong for certain creative domains (e.g., poetry). Although not without controversy, most creativity researchers today agree that the evidence for any real connection between creativity and mental disorder is lacking (see Taylor, 2017).

The 20th Century

During the early 1900s, some of the most influential theorists in psychology wrote about creativity. However, these writings were mostly tangents for those examining mental illness, child development, or gifted education. Sigmund Freud discussed creativity in the context of mental illness, suggesting that creative writers were engaging in fantasy because they were dissatisfied with life. He warned that over-indulging in fantasy would lead to psychosis or neurosis, which both result in a break from reality (though with different underlying causes). Lev Vygotsky discussed creativity in the context of child development, suggesting that children's play is a creative act because they use their imagination to create new meaning from real experiences. During this time, it was rare for creativity to be studied for its own sake.

In 1950, J. P. Guilford, who had just been elected president of the American Psychological Association, gave a speech urging psychologists to study creativity and the creative process. His focus was on understanding individual differences in creativity, or "the abilities that are most characteristic of the creative person" (Guilford, 1987, p. 33). He suggested that creativity was a form of problem solving, which depended on a person's ability to recognize problems (sensitivity), quickly generate ideas (fluency), and adapt to spontaneously produce responses that were both original and high quality (flexibility). Guilford's model of the structure of intellect suggested that all mental abilities are the result of different combinations of cognitive operations, contents, and products. Based on this idea, he distinguished between two different types of thinking and approaching problems: divergent thinking and convergent thinking. Divergent thinking involves generating as many ideas or solutions to a problem as one can and convergent thinking involves narrowing down ideas and solutions by discarding inappropriate or less desirable ones. Divergent thinking is most often associated with creativity by both the public and researchers, and tests developed to measure divergent thinking are still frequently used today. One that is frequently used is the Alternate Uses Task. The AUT asks participants to list as many uses as they can for a common item (e.g., a paperclip or newspaper). The responses are then scored on four factors that Guilford suggested underlies divergent thinking: fluency (the number of responses), flexibility (the number of categories of responses), originality (the uniqueness of responses), and elaboration (the detail provided for responses). Although divergent thinking is frequently used as an indicator of creative potential, Guilford stressed that both divergent and convergent thinking processes were necessary for creative thought and there is some controversy over how much divergent thinking ability relates to creativity.

Guilford's speech coincided with a cultural shift in the United States, which marked a newfound focus on individualism and creative potential. Thus, the 1950s marked the beginning of modern creativity research, and in the decade or two following Guilford's theories, several other theoretical and empirical developments began emerging across many different aspects of creativity. In 1961, Mel Rhodes examined how creativity was being studied. He identified four categories, or strands of research, in the existing literature on creativity. Most creativity research conducted during the mid to late 20th century can be described in terms of these categories, known as the Four P's: Product (the characteristics that make a product creative), Person (the individual differences

that characterize a creative person), Process (the processes underlying creativity), and Press (how the environment influences creativity).

The Creative Product

In early attempts to rate the creativity of a product, researchers proposed criteria based on specific dimensions they believed to be important for creativity (e.g., originality, humor, effort; see Besemer and Treffinger, 1981). The criteria set by individual researchers differed across studies, making it difficult to compare findings and muddying the concept of what constitutes a creative product. In one review, researchers found more than 125 specific criteria that had been used in studies to assess the creativity of a product (Besemer and Treffinger, 1981). However, the criteria used in early studies can be distilled down to two: novelty and appropriateness (though some earlier studies also incorporated elements of style or aesthetic considerations). Indeed, the definition of creativity as something “novel and appropriate” had become popular among creativity researchers before this time. That a product must be novel, or new, to be creative is somewhat intuitive. Perhaps for this reason, more research and public attention has been paid to the novelty component of creativity. However, the appropriate or usefulness component is also necessary for a product to be considered creative (Kaufman, 2016). Without novelty, an idea or product is mundane, but without appropriateness, it is nonsense.

In the latter part of the 20th century, with a growing focus on socio-cultural creativity, Teresa Amabile created the Consensual Assessment Technique (CAT). The CAT, which is based on the premise that the subjective creativity ratings of those in a given field are more similar to the way creativity is judged in real life, entails having multiple individuals with some degree of expertise in an area rate the creativity of products created by participants (e.g., poems, drawings, mathematical equations). Importantly, the raters are not given a formal definition of creativity but are asked to use their own understandings of the term. If the ratings demonstrate sufficient inter-rater reliability (i.e., the pattern of ratings is similar across judges), the sum or average of the ratings can be used as an indicator of creativity. The CAT is the most widely used method of assessing the creativity of a product.

The Creative Person

Much of the theory developed following Guilford’s speech focused on the characteristics that make a person more-or-less creative. Sarnoff Mednick’s theory about how individual differences contribute to creativity were based on his Associative Theory (1962), which suggests that creative ideas are the result of combining existing concepts in our semantic memory (i.e., learned knowledge). Because to be creative an idea must be novel, more creative ideas come from combining less obviously related (i.e., more remote) concepts. Mednick suggested that people who are able to combine more remote concepts to form ideas have relatively broader associative hierarchies (i.e., concepts stored in their memory are loosely associated with a wider variety of other concepts, rather than being strongly associated with a few). Mednick’s Remote Associates Test (RAT; Mednick, 1962) is based on this theory, and is still widely used today. The RAT asks a person to provide the one word that relates to each of three given (conceptually distant) words (e.g., providing the word *bag* when given the words *sleeping*, *bean*, and *trash* = *beanbag*, *sleeping bag*, *trash bag*). Gerald Mendelsohn later suggested that, rather than being based on fixed associative hierarchies, individual differences in the ability to combine remote concepts is due to a broad (as opposed to narrow) focus of attention (i.e., the ability to hold relatively more concepts in your mind at once). According to this view, a more creative person has more concepts in their mind simultaneously, increasing the odds of combining concepts in new ways.

Many researchers (such as Guilford) believed that creativity was a component of intelligence. However, E. Paul Torrance suggested that creativity and intelligence were distinct abilities and proposed the Threshold Hypothesis to explain how creativity relates to intelligence. The Threshold Hypothesis suggests that a moderate level of intelligence is necessary to be creative, so intelligence and creativity should be moderately correlated up to a certain point (e.g., an IQ of 120). However, after reaching this threshold, they should no longer be correlated. He built on earlier work on the role of divergent and convergent thinking in creative ability to develop the Torrance Tests of Creative Thinking (TTCT). The TTCT asks participants to complete a series of figural and/or verbal tasks, such as completing drawings using two parallel lines or coming up with many different consequences for an unlikely event (like rope hanging from clouds). A series of longitudinal studies, beginning in the 1950s and spanning 50 years, demonstrated that ones’ performance on the TTCT as a child could predict later creative achievement and accomplishment better than general intelligence. Although the TTCT remains a popular way to measure creativity today, there is some debate about how well divergent thinking relates to creative achievement.

Examining the issue of what makes a person more-or-less creative from a different perspective, researchers at the Institute of Personality Assessment and Research (IPAR) at UC Berkeley worked to create measures examining the personality and individual difference variables related to creativity. One measure, Harrison Gough’s Creative Personality Scale (CPS) is a self-report checklist that asks participants to select which items apply to themselves from a list of adjectives found to distinguish between people who are creative (e.g., clever, resourceful, and unconventional) and those that are considered to be not creative (e.g., conservative, submissive, and commonplace). The Barron-Welsh Art scale was created based on Frank Barron’s research, which demonstrated that artists and other creative people prefer complex, non-symmetrical figures. Participants indicate which of a series of figures they like and dislike and receive higher scores for liking figures that are complex and non-symmetrical. Although these measures are still used by researchers today, the Five-Factor Model of personality has been used the most to study how personality relates to creativity. Openness to experience has been the strongest and most consistent predictor of creativity out of the five traits (i.e., extraversion, agreeableness, emotional stability, conscientiousness, and openness to experience).

The Investment Theory of Creativity (Sternberg and Lubart, 1992) was developed based on Robert Sternberg's idea that a certain cognitive style, intelligence, and personality/motivation is necessary for a person to be creative. This theory suggests that recognizing ideas that are undervalued and convincing others of their value (skills needed to be a successful creator) requires a person to have the appropriate motivation, intelligence, knowledge, personality, thinking styles, and environment. This enables them to recognize, develop, and sell (persuade others about) their creative ideas.

The Creative Process

The creative process, the mental processes by which creativity occurs, is suggested to progress through a series of stages. Graham Wallas (1926) proposed a well-known five step model of creativity which included the stages of preparation, incubation, insight, verification, and elaboration. Preparation (defining a problem and gaining relevant knowledge), verification (selecting the best ideas), and elaboration (bringing an idea to fruition and evaluating its usefulness) refer to conscious, effortful processes. However, the incubation stage is characterized by the unconscious "forming of associative elements into new combinations" (Mednick, 1962, p. 221) that occurs when an individual is either in a relaxed state or working on a non-related problem. This associative processing leads to the insight stage, the moment when the idea reaches consciousness, in a moment of sudden insight (Wallas, 1926).

Wallas' model is still used by modern researchers and many models have been developed by expanding on these concepts. In general, these models continue to suggest three phases: 1) a preparation/problem recognition phase, characterized by gaining the knowledge and experience necessary to recognize that a problem requires a creative solution and to form creative ideas; 2) an inspiration and generation phase, characterized by forming or discovering a creative idea; and 3) a verification and implementation phase, characterized by the evaluation and implementation of an idea.

Alex Osborn (1953) suggested that idea generation may be enhanced by brainstorming, allowing a group of people to offer any possible relevant ideas or solutions to a problem without the danger of being criticized. The main assumption in brainstorming is that quantity (as in number of ideas) will lead to quality. Although brainstorming continues to be used today, there are a number of factors that can limit its effectiveness (Paulus and Brown, 2007).

Theories of the way people get and evaluate ideas that were created later in the 20th century include the Geneplore (for generate-explore) model and Simonton's Blind Variation and Selective Retention theory. Simonton's theory suggests that created ideas are generated by a random combination of conceptual elements, which are subsequently retained or eliminated, similarly to the process of natural selection.

Both the general public and scientists have traditionally focused most attention on the inspiration phase, because it aligns more with the colloquial meaning of creativity (as ideation and the "aha!" moment of inspiration). However, creativity researchers are becoming increasingly more interested in understanding the preparation, problem recognition, and implementation phases.

The Creative Press

Although there was talk about examining creative press (i.e., external factors that influence creative production) during the time Rhodes (1961) conducted his review, theories incorporating the role of social context did not begin to emerge until the 1980s. Key to this development was Teresa Amabile's (1983) Componential Theory of Creativity, which suggests that creativity depends on domain-relevant skills, creativity-relevant skills, and task motivation. In a series of studies, Amabile demonstrated that an individual's creative performance can be diminished by external factors that affect task motivation (such as the threat of evaluation). For example, creative writers who were asked to write a haiku-style poem after listing intrinsic reasons for writing creatively (i.e., reasons related to enjoyment or personal fulfillment) wrote significantly more creative poems than those asked to list extrinsic reasons (i.e., reasons related to external reward or punishment) and a control group.

Mihaly Csikszentmihalyi's Systems Model represents an even more contextual perspective of the role of the environment in creativity, looking at how the person, field, and domain influence one another. He suggested that because the gatekeepers in a field (i.e., the people in positions of authority who promote, evaluate, or recognize creativity) change, how a creator and his or her work are viewed in a given time and place changes. The domain or the cultural areas that welcomes what is being created also changes over time and across contexts. As such, the domain and those involved (i.e., practitioners and consumers) influence both how the work is viewed and the creator's subsequent work.

Creativity Today

Creativity research grew substantially in the latter part of the 20th century (and into the 21st century), leading to a more nuanced understanding of creativity and how its different components relate to one another. Research now frequently studies how the categories within Rhodes's (1961) 4Ps framework (i.e., person, process, product, press) interact. Vlad Glăveanu (2013) presented an updated framework, the Five A's, to account for the greater complexity of creativity research and theory today. The Five A Framework re-conceptualizes the categories of creativity research as actor, action, artifact, audience, and affordance. Actor refers to personal attributes (i.e., person) in relation to a sociocultural context, because the sociocultural context in which we are socialized influences the ideas we generate and how we present them to others. Action refers to creative activities (i.e., process) directed by goals, which are influenced by a particular context and rely on a series of external and internal feedback loops (instead of being a linear series of

stages). Artifact refers to how creations (i.e., product) are influenced by personal interpretations of sociocultural symbols that connect people through a shared sense of meaning. Audience refers to others in our environment (i.e., press) that influence creations (e.g., assisting, being inspired by, consuming or rejecting a creation). Affordance refers to how the materials and limitations of the physical environment (i.e., press) influence our opportunities for creating.

Researchers have also begun to delve into the complexities of the construct of creativity itself. Building on the concept of the distinction between Big-C (creative contributions that make lasting and far-reaching impact) and little-c (creative behaviors and activities that people may engage in during daily life), James Kaufman and Ronald Beghetto proposed the Four C theory of creativity to incorporate a more complex understanding of the different levels of creativity and how they might develop. Mini-c creativity, which occurs when someone has an insight that is personally meaningful and new to that person, can evolve into little-c, which is recognized as creative by other people, with feedback and guidance. It can then evolve into Pro-c, professional or expert creativity (Kaufman and Beghetto, 2009), with years of deliberate practice. It may further develop into Big-C or historically recognized creativity, though this occurs for relatively few people and is usually posthumous.

Additionally, creativity researchers began developing models to reconcile the concepts of creativity as a general ability that is the same across all contexts (domain general) and creativity as an ability that differs from one area to another (i.e., painting vs. physics; domain specific). For example, James Kaufman and John Baer proposed the Amusement Park Theoretical model (APT; Baer and Kaufman, 2005), which uses an amusement park metaphor to describe how creativity contains elements of domain generality, but becomes increasingly more specific within different domains. Just as a person must have an admission ticket and transportation, a potential creator must meet certain initial requirements (e.g., sufficient motivation and cognitive ability) in order to be creative. If these initial requirements are met, a person must decide which type of amusement park to go, just as someone must decide which general thematic area (e.g., arts or sciences) in which to be creative. A person must then choose a park in that area, just as one must choose a specific creative domain (e.g., painting vs. sculpture) in which to be creative. Finally, a person must choose which activity or ride to go on at the park, just as one must choose a microdomain (e.g., landscape vs. abstract painting) in which to be creative.

Concluding Remarks

Our understanding of creativity has continuously changed through the ages, and will no doubt continue to evolve. This review highlighted the historical origins of our modern conceptualization of creativity and how its development has been influenced by the changing socio-cultural circumstances and ideals of society. It is important to note here that our view of creativity, at least in the West, went through several stages of gradual ‘internalization’ (i.e., of making creativity an intra-psychological phenomenon). The Renaissance and Romanticism contributed greatly to this major conceptual shift from creativity understood as the feature of gods or the collective, for example various guilds, and towards creativity as a personal trait, something that special people truly ‘possess’.

A second major change had to do with how inclusive or restrictive the notion of creativity was through the centuries. If in antiquity the notion of genius was used to designate the protective spirit of a place or family, the word genius today has a much more exclusive connotation. From the 1950s onwards, however, we are witnessing a ‘democratisation’ of creativity through an emphasis on creative potential assumed to be characteristic for each and every individual – once more, it is the person and not the collective coming to the front.

The recent development of psychometric tests of creativity, at the scale of history, capitalized on both these historical trajectories. It is a 2nd century of interconnectivity and interdependence that brings back systemic or distributed approaches to this phenomenon and advance our understanding of it. The history of creativity is, in many ways, the history of humanity. What we create, individually and collectively, not only makes history but the development of our societies and its new directions feed back into how we think about and ultimately how we study and practice our own creativity.

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Background

Historiometric research examines the big names and important happenings that can be considered historic in the sense of “making history.” For example, the subjects of historiometric studies may involve eminent artists, writers, or scientists (e.g., Leonardo da Vinci, Cervantes, or Einstein) or they may entail major acts of creativity such as musical masterworks or major scientific discoveries (e.g., Beethoven’s Fifth Symphony and the heliocentric theory of Copernicus).

The database concerning these historic subjects is compiled from various archival sources, such as histories, biographical dictionaries, encyclopedias, anthologies, and collections. The data may also be derived from the content analysis of creative products, including the computer analysis of music and literature. Because historiometric research concentrates on individuals or products that are highly distinguished, the archival information on these cases is often extremely rich.

The goal of the study is nomothetic rather than idiographic. Nomothetic research involves the quest for general psychological laws or patterns, whereas idiographic research concentrates on those features that are unique to a particular individual or event. Thus, nomothetic research addresses such questions as whether creative development is enhanced when talented individuals are exposed to models of creativity. In contrast, idiographic research might address an issue such as the reason why van Gogh cut off his ear. Hence, in this sense historiometrics has goals comparable to other methods that psychologists use to study creativity, such as psychometrics.

In line with this focus, historiometric research favors multiple-case investigations. Only by obtaining a large sample of eminent personalities or important events can the researcher ensure that the findings are truly general rather than particular. It is rare for a historiometric inquiry to analyze fewer than a dozen cases, and sometimes the sample sizes may run into the thousands. Indeed, the largest number of cases ever examined in a single historiometric inquiry was 15,618, a very large sample size indeed (Simonton, 1980).

Also consistent with the search for nomothetic results, historiometric research invariably entails quantification. Variables are first quantified from the available archival materials, and then these variables are subjected to statistical analysis. Because the number of variables studied will often be very large, the investigator usually must apply sophisticated multivariate statistics to tease out the

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complex interrelationships among the variables. The most commonly used statistics are multiple regression and factor analysis, but occasionally one sees studies using path analysis, latent-variable models, time-series analysis, multidimensional scaling, and hierarchical linear models. Needless to say, given the typical sample sizes and the complexity of the statistical analyses, historiometric studies almost invariably must be executed on a computer.

Comparisons

It is important not to confuse historiometric research with several alternative approaches. To begin with, historiometry differs substantially from psychobiographical and psychohistorical studies of creativity. The latter almost always employ qualitative rather than quantitative methods, and they tend to be idiographic rather than nomothetic in orientation. In addition, psychobiographical and psychohistorical inquiries are very often psychoanalytic in theoretical emphasis. These characteristics are evident in the classic psychobiography of Leonardo da Vinci that was published by Sigmund Freud in 1910. Historiometry, in contrast, is a method designed to test hypotheses that might be drawn from any theoretical framework, psychoanalytic or otherwise. An excellent example is Colin Martindale's 1990 book *The Clockwork Muse*, in which the author tests a formal model of stylistic change that has roots in psychoanalytic theories of creativity.

Another approach is sometimes confused with historiometry is the comparative. Comparative research takes a modest size sample of individuals or events and then tries to discern consistent patterns or regularities. Although the goal is often nomothetic, the method is qualitative. A good illustration is Howard Gardner's 1993 book *Creative Minds*, in which he carefully compares and contrasts the lives of seven eminent individuals. Comparative studies can lead to important insights about creativity and other phenomena but do not share historiometry's capacity for more precise model testing and prediction.

Lastly, historiometry must not be equated with cliometrics (Simonton, 2008). Although the two terms have similar etymologies—both literally mean “history measurement”—cliometrics has become associated with quantitative research in economic history. Here the goal is to test a historical question by applying econometric methods and economic theory to archival data. A classic example is the cliometric research on whether slavery was a profitable business in the antebellum US South. Although important, this issue has no psychological content, nor does it concern creative geniuses.

History

Surprisingly, historiometry actually represents the earliest scientific approach to the study of creativity. In 1835 Adolphe Quételet published a quantitative analysis of eminent English and French playwrights in which he established the relationship between age and creative output. The next important historiometric inquiry was the 1869 book *Hereditary Genius*, in which Francis Galton documented how eminent creativity (and leadership) tends to run in family lineages. Other pioneer historiometric investigations include Alphonse de Candolle's (1883) study of eminent scientists and Havelock's (1904) study of British geniuses.

However, none of these researchers explicitly identified their work as historiometric, for the term had not yet been invented. The word was not coined until the first decade of the 20th century, when Frederick Woods (1909) and (1911), a geneticist, patterned the term after biometrics. Although Woods's own historiometric research focused more on famous leaders than creators, the term was adopted briefly by others. Most notably, Catharine Cox's (1926) study of the *Early Mental Traits of Three Hundred Geniuses* was explicitly labeled a historiometric inquiry. This monumental investigation, which constitutes the second volume of Lewis Terman's (1925–1959) *Genetic Studies of Genius*, provided quantitative assessments of the intelligence and personality of famous creators and leaders.

Cox's work inspired other historiometric studies, but unfortunately both the method and the term virtually disappeared from the research literature on creativity. Beginning in the mid-1970s, Dean Keith Simonton began to revive the technique and the name. At present, historiometry seems to represent a relatively rare but nonetheless acceptable approach to the study of creativity. Indeed, from time to time it has attracted the efforts of eminent psychologists whose primary contributions have employed very different methods. Among these holiday historiometricians are James McKeen Cattell, Raymond B. Cattell, B. F. Skinner, Lewis Terman, and Edward L. Thorndike.

Research

One of the reasons that historiometric research may be here to stay is the tremendous amount of important empirical results it has generated. The great diversity of findings may be grouped into two inclusive categories: those concerning the creative individual and those concerning the creative product.

The Creative Individual

The largest proportion of historiometric studies of creativity examines those individuals who have achieved acclaim for their original contributions to some domain. These studies have tended to focus on the following three topics:

Individual Differences

Even among eminent creators, the cross-sectional variation in creative success is quite substantial. To appreciate the contrast, we need only compare Newton with William Higgins, Descartes with Henri Duroy, Shakespeare with Chatterton, Michelangelo with Hendrick Bloemaert, Beethoven with Anton Reicha—all pairs of individuals who have rubbed elbows in the same historiometric samples. Much of the contrast in differential reputation can be ascribed to differences in creative output. Accordingly, many studies have examined individual differences in lifetime productivity, including the peculiar skewed (or elitist) distribution of that output. Other studies have examined the personality and intellectual factors responsible for the cross-sectional variation in output and eminence. For example, Cox showed how success required a combination of both high intelligence and unusual motivational persistence. She also demonstrated how the distinctive personality profiles of eminent creators vary according to the domain of creative activity.

Life-Span Development

Rather than concentrate on individual differences, many historiometricians have studied how creativity develops and manifests itself across the life span. These developmental inquiries fall naturally into two distinct categories. In the first category are those that look for the early antecedents of adulthood creativity. For instance, researchers have examined the impact of such variables as family pedigree, socioeconomic class, childhood precocity, birth order, orphanhood, role models and mentors, crystallizing experiences, and formal education or special training. [See Birth Order; Enhancement of Creativity; Families and Creativity; Prodigies.]

In the second category are those developmental studies that scrutinize how creativity varies across the course of the career. Most of these studies are concerned with how the rate of output changes with age. The expected age curves tend to vary systematically according to the specific type of creativity. For example, poets and mathematicians tend to produce masterworks at younger ages than do novelists and earth scientists. Other studies have examined the longitudinal relation between total quantity of output and the odds of producing a masterwork. Significantly, a creator's best work tends to appear in those periods of the career in which he or she is the most prolific overall.

Sociocultural Context

Illustrious creators are not randomly distributed across history, nor are they evenly spread across the globe at any one time. On the contrary, creative genius is more prone to appear during "golden ages," less likely during "silver ages," and supremely unlikely during "dark ages." The Golden Age of Greece is a classic example. Such uneven distribution suggests that political, economic, social, and cultural forces may play a major role in the development and manifestation of creative talent. Historiometric investigations have specifically examined such factors as war, political system, ideology, and general intellectual ferment. These studies show that the "spirit of the times," or the *zeitgeist*, claims a crucial part in the origination of creative genius. The *zeitgeist* influences not only the number of eminent creators that appears in a given time and place, but also the particular domains in which creativity is most likely to be displayed. [See *Zeitgeist*.]

The Creative Product

Because the eminence of a creator is very much contingent on the works he or she contributes to posterity, it is natural for historiometricians to investigate the characteristics of these artifacts of the act of creation. Some of this research has examined scientific discoveries and technological inventions. For example, several studies have been published on the multiples phenomenon where two or more scientists independently (and sometimes simultaneously) arrive at the same idea at about the same time. Classic illustrations include the proposal by Charles Darwin and Wallace of the theory of evolution by natural selection and the invention of the calculus by Newton and Leibnitz. Surprisingly, certain distinguishing features of these events—such as their timing and the number of participants—can actually be accurately predicted using mathematical models. [See Creative Products.]

However, most inquiries into the creative product focus on the arts. Many of these studies are specifically devoted to the determination of the factors responsible for aesthetic effectiveness of compositions in literature, music, or the visual arts. For instance, the application of computerized content analysis to classical music has enabled researchers to predict the relative performance frequencies of works in the repertoire. Similar historiometric techniques have had comparable success in the prediction of the differential popularity of literary creations, such as poetry. In addition, several historiometric studies have been concerned with qualitative changes in the nature of the works produced over the course of a career. Of special interest are inquiries into the swan songs of classical composers and the late-period style changes in visual artists. The research shows that toward the very end of a creator's life the very nature of her or his creative output may undergo a dramatic transformation. [See Art and Aesthetics.]

Evaluation

The reason why the behavioral scientists have so many different techniques at their disposal is because no technique is perfect. Each enjoys certain assets, and each suffers from certain liabilities. Historiometry is no exception. It, too, has both advantages and disadvantages. Let us look at the latter before turning to the former.

Disadvantages

Any researcher interested in applying historiometric methods to the study of creativity must often confront one or more of the following four problems:

Causal Inference

Methodologists sometimes distinguish between internal and external validity of a technique. The former criterion concerns the security of the causal inferences the method permits. Laboratory experiments enjoy very high internal validity because the experimenter actively manipulates the independent variables and randomly assigns subjects to experimental and control groups. Historiometric research, in contrast, is inherently correlational in nature. The best the researcher can do is to determine how measured variables are associated. Because other unmeasured factors may contaminate the observed relationships, conclusions about causal influence are invariably insecure. Correlation never can be taken to prove causation. Thus, the internal validity of historiometric work is almost always inferior to that found in the experimental literature. For example, one of the oldest debates in the study of creativity is the relationship between genius and madness. What makes this issue especially irksome is the difficulty of determining which of three distinct possibilities is most likely to hold: (a) a proclivity toward psychopathology might make a positive contribution to creativity; (b) exceptional creative achievement might put exceptional strain on creative individuals, thereby making them more disposed to mental and emotional breakdowns; and (c) neither creativity nor psychopathology may have any direct causal relationship with each other but rather might be the consequence of some other factor or factors (e.g., traumatic or unconventional childhood experiences. [See Mad Genius Controversy.]

Data Quality

Because the historiometrician must rely so much on the historical and biographical record, sometimes the available information leaves much to be desired from a scientific standpoint. For example, when Cox (1926) attempted to calculate IQ scores for historic personalities, she lamentfully discovered that she had to exclude William Shakespeare from her sample. There exists very little data about the Bard's personal life and virtually nothing about his early years. Even when enough pertinent information could be found in the historical record for a particular individual, Cox found that the reliability coefficients for her IQ assessments could vary substantially from genius to genius. Moreover, when she wished to estimate 67 personality traits for her subjects, she was obliged to restrict her sample to the 100 famous people about whom the most data were available.

Substantive Applicability

Closely related is the fact that some important issues in the scientific study of creativity probably cannot be addressed using historiometric methods. For instance, one of the central questions in the creativity literature is the very nature of the creative process. What is the role of intuition or unconscious processes? What is the function of logical analysis? Yet the biographies and published letters of eminent creators do not contain the necessary information in any systematic fashion, and when the records do, they cannot always be trusted as sources of solid data. For example, Samuel Coleridge's description of the creative process underlying the composition of "Kublai Khan" is inconsistent with his own unpublished manuscripts that contain the various drafts of the poem. It is now apparent that he distorted his narrative to render the episode more consistent with romantic notions of the creative process.

Labor Requirements

Perhaps the most prohibitive drawback of historiometric research is the sheer amount of work required to carry out a project. Collection of the raw data may require many trips to the library and special archives, followed by the arduous coding of qualitative information to get the data in quantitative form. Even after the content analytical, historical, and biographical data have been reduced to numbers, the statistical analyses may consume considerable amounts of time. Historiometric data sets often involve numerous variables with highly complex interrelationships that can only be teased out using the most advanced statistical techniques. As a consequence, it is not uncommon for a major historiometric study to require several *thousands* of hours of effort to produce a single journal article. That is a small payoff in comparison to, say, a laboratory experiment in the area of creative problem solving. Naturally, monograph-length investigations may demand even more time and effort. To offer one dramatic example, Frank Sulloway's book *Born to Rebel* represents the culmination of 26 years of intensive data collection and analysis.

Advantages

The forgoing liabilities notwithstanding, often one or more of these problems can be alleviated if not entirely removed in well-conceived historiometric research. First, multivariate statistics and quasi-experimental designs have immensely increased the power of drawing causal inferences from correlational data. One especially potent inferential tool is time-series analysis. Second, data quality problems can often be handled by the introduction of more sophisticated statistical methods, such as latent-variable models. These permit the explicit incorporation of measurement error into the causal model. Third, the substantive applicability of historiometry can often be greatly extended if the investigator exercises care in selecting the optimal research site. For instance, sometimes a researcher may examine famous creators from non-Western civilizations precisely because the biographical and historical information is available regarding a particular set of variables. Fourth, if the investigator plans carefully and compiles a rich

enough database, it is possible to generate more than one publication from a single data collection. For example, once a researcher decides on using a particular sample of Nobel laureates as the basis for the investigation, he or she can gather a great diversity of biographical, historical, and content analytical data that can be used to test a wide variety of hypotheses.

Besides these extenuating circumstances, researchers often have very strong reasons for adopting historiometric methods for a particular investigation. Five assets may be the most important from the standpoint of creativity research.

Criterion Validity

One of the main problems in studying creativity is how to measure the phenomenon. Some researchers may define creativity in terms of scores on a psychometric instrument, whereas others may rely on judges' evaluations of creative products. Although these conventional assessments have much to recommend them, they are also not without conspicuous limitations. For example, a measure cannot be called a "creativity test" without first validating the instrument against some more secure criterion of creativity. Perhaps scores on such tests have absolutely nothing to do with real-life creativity. Historiometric research circumvents this problem by studying those individuals who have made a name for themselves precisely for their creative achievements. If the investigator examines persons like Planck, Sartre, Joyce, Picasso, or Stravinsky, we have no other option but to assume that these individuals exhibit creativity. If we were to deny that attribution, the term *creative* would lose all meaning. Hence, historiometric methods take their point of departure at those individuals who best exemplify the phenomenon under investigation.

Variable Accessibility

There are many important influences on creativity that for both practical and ethical reasons can only be examined using historiometric methods. If the goal is to determine the sociocultural milieu that best contributes to the development of creative development, it is hard to imagine a better method than to scrutinize the historical record with respect to the coming and going of creative genius. For instance, if we want to test the hypothesis that wartime conditions inhibit the expression of creativity, we probably have no other choice than to conduct a time-series analysis comparing the output of creative products against the magnitude of political violence (*See War*). Even if the focus is on creative careers, the assets of historiometrics are paramount. The researcher can examine the emergence and manifestation of creative genius from the moment of conception (e.g., family pedigrees) to the moment of death (e.g., swan songs) and everything in between (e.g., birth order, childhood trauma, role models and mentors, education and special training, and career trajectory). Historiometry is thus truly life-span developmental in scope.

Unobtrusive Measurement

Ever since the advent of the Heisenberg uncertainty principle in quantum theory, physicists have learned that the very act of measuring a phenomenon may interfere with the phenomenon under scrutiny. A similar consequence often may be seen in many standard methods in the behavioral sciences. For example, the very act of studying the creative process in the laboratory may distort the observed behavior to such a degree that it becomes unrepresentative of what would happen under more natural conditions. Similarly, the application of psychometric measurement, surveys, and one-and-one interviews to samples of contemporary creators may produce expectancy effects, "guinea-pig" effects, and other kinds of artificial reactions. Historiometric measurement, in contrast, is totally unobtrusive. The subjects in historiometric inquiries do not know that they are under observation. Indeed, because the subjects are most often deceased, they will never find out the results. Accordingly, the phenomenon of creativity can be investigated without fear of inducing unnatural responses from the subjects of the study.

Cross-Cultural and Transhistorical Invariance

Behavioral scientists seek general laws or principles of behavior that transcend place and time. If an empirical relationship only holds for a particular culture or is merely valid for a single historical period, it cannot have the claim to universality that is the hallmark of all nomothetic science. For example, Newton's law of gravitation holds not only for apples falling from trees in 17th-century England but also for all massive bodies in the universe throughout the history of time. One great asset of historiometric research is that it can sample creators from all civilizations of the world and from every major historical period. Hypotheses tested on such diverse sample have a much higher probability of claiming cross-cultural and transhistorical invariance. For instance, one historiometric investigation of literary creativity showed that poets produce their best works at younger ages than prose writers. Furthermore, this differential was shown to be invariant across historical time and geographical origins. Because the sample consisted of hundreds of literary figures drawn from all the world's major literature from antiquity to the present day, we can have greater confidence that this result is not confined to, say, such 19th-century British authors as Keats, Shelley, and Byron.

Unit Replicability

One of the peculiarities of historiometric research is that the subjects who compose its samples can all claim a permanent and distinct identity. After all, the individuals under scrutiny have made a lasting name for themselves on the basis of their creative contributions to human culture. As a consequence, it is not uncommon for historiometric studies to identify their subjects by name, listing them either in a table or in an appendix. For instance, Cox listed all 301 geniuses whom she studied along with some of the basic information compiled about each, including the estimated IQ scores. Other times the researcher will give sufficient details about the sampling procedures—such as the precise biographical dictionaries used—that any reader can easily determine who the famous personalities under investigation were. In any case, because the subjects are identified or identifiable, subsequent investigators can study exactly the same individuals, adding new variables and altering the statistical analyses

performed. For example, the eminent persons in the Cox study have been re-examined in several follow-up inquiries published over an 80-year period.

This asset of unit replicability allows the historiometrician to improve on previous results in a manner that can accelerate the accumulation of scientific knowledge. Most alternative methods lack this feature. A laboratory experiment can always be replicated in terms of method, but not in terms of subjects. As a consequence, when experiments fail to replicate a previously published finding, it is uncertain whether the contrast may be ascribed to the change of participants in the study. In contrast, when a historiometrician scrutinizes the exact same subjects as analyzed in a previous study and fails to obtain identical results, the cause of the discrepancy can be more easily isolated.

Conclusion

Because historiometry has already been around in the behavioral sciences for more than 180 years, its use will likely continue in the future. The technique has already made considerable contributions to our understanding of creativity in its most historic manifestations. Moreover, the method enjoys many methodological advantages over other research strategies. Above all, it is the technique of choice for anyone who wants to test nomothetic hypotheses about history-making creativity. No alternative method features the same inferential rigor and quantitative precision. Moreover, despite various methodological disadvantages, many of these drawbacks are becoming ever less critical. Certainly statistics for analyzing correlational data are becoming increasingly sophisticated, permitting ever more powerful causal inferences. Even more important, the quality of the data about historic creators is becoming increasingly better with time. After all, creativity is not dead in the world, and each generation will usually produce a new crop of eminent creators that can serve as subjects in future historiometric research. Furthermore, there will probably be more and better information about these forthcoming creative individuals than holds for those born in earlier historical periods. Indeed, historiometric research has actually demonstrated that the reliability coefficients for many variables have increased over time. Finally, with the advent of the internet, the available information has not only become more detailed but also more accessible. The investigator can often download all or most of the data for a particular historiometric inquiry directly from an internet database.

In a sense, the situation for the historiometrician is very similar to that of the astronomer centuries earlier. The first astronomical measurements were rather too imprecise to support anything more than the crudest planetary theories. But as observations became more precise, the archival records collected by astronomers began to encourage the development of increasingly sophisticated theories. I predict that historiometry will enjoy the same historical trend with respect to its own phenomena. In fact, in some respects it has already done so. As mentioned in the section on the method's history, the first historiometric study ever published dates back to 1835. That investigation concerned the relationship between age and creative productivity. Since that pioneering inquiry, many investigators have scrutinized the same question using ever more precise measurement and statistical analysis. Now the cumulative body of evidence on this question has reached the point that researchers have begun to propose mathematical models that provide rather precise predictions about how creative output changes across the life span. Hence, in this substantive domain at least, historiometrics can indeed provide the foundation for scientific progress in our comprehension of creativity. The same progress should be seen with respect to other topics that attract historiometric inquiry.

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Humor

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Introduction

Like creativity, humor makes life worth living. Both play central roles in our mental and social lives, and both appear to be uniquely human (or nearly so). As topics of scientific inquiry, they also have much in common – conceptually, methodologically, and in proposed explanatory frameworks. Both humor and creativity involve a person producing something (such as an artwork, a scientific theory, or a joke) that is regarded by some audience as novel, unexpected, and valuable (or funny). Within the context of humor research, the topic of creativity is most directly relevant to humor production: how a person generates a new joke, witticism, observation, or other creative product that is found funny by others. Additional facets of the psychology of creativity – including underlying cognitive mechanisms, issues of reliability and validity of measurement, personality, and evolutionary origins – are also relevant.

This entry will outline some basic features of the psychological study of humor and describe conceptual links between humor and creativity, encompassing both classic and contemporary lines of scholarship. Then work in a few specific research areas relevant to the nexus of creativity and humor will be explored. These include their psychometric relations, the influence of personality, the association between humor and the “a-ha!” phenomenon of insight, the relation of humor production to allied constructs like humor comprehension and appreciation, and an overview of recent research attributing the evolutionary emergence of humor and creative abilities to Darwinian sexual selection. In each case, possible future research directions are outlined, which would further develop these potentially fruitful but still under-studied and under-integrated topics.

The Psychology of Humor

The psychology of humor is a specialized yet rich area of research. It draws upon virtually all the main methodologies and subdisciplines within psychology, including psychodynamic, cognitive, developmental, social, personality, psychobiological, health, and evolutionary perspectives. Humor is a human universal. It involves a suite of cognitive-perceptual and emotional processes deployed in particular social contexts and supported by biological markers like smiling and laughter. Its expressions include formalized jokes, spontaneous conversational humor, and unintentional instances of humor. Humor also pervades creative domains like cartoons, literature, theater, films, and even instrumental music – as in Mozart's *A Musical Joke* (K. 522), a matchless parody of compositional and performative incompetence. Humor serves varied purposes, many of which are social in nature. These include interpersonal bonding via the positive emotion of mirth, direct and indirect communication, signaling of group membership, social influence, conflict de-escalation and tension reduction, and displays of status or genetic fitness.

Psychological theories of humor address many questions. These include the various functions of humor, the cognitive processes required to 'get' a joke, like creating and then resolving incongruities or engaging in cognitive reversals, humor's developmental stages, and different styles of humor, including affiliative, aggressive, self-enhancing, and self-defeating.

In sum, the psychology of humor encompasses a range of topics, which are comparable in scope and complexity to issues raised in the psychological study of creativity: indeed, there are many fertile links between the two areas.

Links Between Creativity and Humor

Earlier Views

Despite close conceptual links between humor and creativity, historically there has been a pragmatic separation between the two fields. Most creativity researchers do not study humor, and vice-versa; those who do research in both areas tend to be mainly associated with only one; few researchers are equally conversant with both topics, and those that are often have primary roots in yet a third domain. Emblematic of this dissociation, [Runco's \(2007\)](#) comprehensive textbook on creativity contains only a single page reference to humor; [Martin's \(2006\)](#) equally comprehensive textbook on humor has only seven page references to creativity (Each book consists of over 400 pages.) And just as scholars of creativity often publish in specialized journals on their topic, humor also has its flagship *HUMOR: International Journal of Humor Research* (<https://www.degruyter.com/view/j/humr>).

Despite this parallel play, over the years a trickle of research has attempted to integrate the two areas. Indeed, psychological researchers have long treated creativity and humor as closely related constructs. Mainstream conceptions of both humor and creativity involve unpredictability, novelty, incongruity, and surprise, and both require playfulness and risk taking. Humor and creativity each show pronounced individual differences and both are regarded as desirable personal characteristics. A sense of humor has long been regarded as a characteristic of creative individuals. At times, humor has been regarded as a subset of creativity or as a separate but partially overlapping domain. Understanding the psychometric relations between aspects of humor and creativity raises questions that mutually inform both constructs, but a more detailed discussion of this topic will be reserved for later.

Some theoretical treatments of humor show striking similarities to venerable theories of creativity. For instance, [Apter's \(1982\)](#) 'reversal' theory of humor emphasizes cognitive processes of a 'play' orientation to the world and one's actions in it. In outlining his theory, Apter described a cognitive process in which two contradictory ideas are simultaneously held in mind, which closely resembles the 'bisociation' view of creativity described by [Koestler \(1964\)](#). Similarly, a common characterization of humor as exploiting loose but meaningful associations between concepts echoes the classic notion of remote associations between concepts as ideational grist for the creativity mill. Further, some measures of creative ability or personality include assessments of humor among the survey items.

Finally, it is worth noting that one early psychological theory of humor was proposed by [Daniel Berlyne \(1972\)](#), a major figure in the history of psychological aesthetics (and by extension, creativity). Berlyne proposed that both aesthetic creative products and humorous productions are characterized by so-called collative variables, such as novelty, surprise, ambiguity, and incongruity, which naturally attract our attention and boost arousal. These same variables (and their underlying arousal-increasing mechanisms) are thought to play a central role in the creation and stylistic evolution of creative works in virtually all aesthetic domains. While art and humor share such attributes, Berlyne also suggested that humor is distinguished from other aesthetic experiences by its typically brief timescale over which changes in arousal occur, the presence of cues that preclude seriousness, and the extreme bizarreness of the collative variables involved in humor.

Contemporary Views

The 'classic' work reviewed so far is typically multiple decades old and mainly originated within humor (rather than creativity) studies. However, this line of inquiry flows naturally into contemporary conceptions and frameworks of mainstream creativity research. Indeed, there has been no shortage of challenging scientific questions (and opportunities for synergy) on these fronts, since both humor and creativity are complex, multi-faceted, and interdisciplinary phenomena, presenting researchers with a host of conceptual and methodological hurdles. In attempting to meet such challenges, creativity researchers have converged upon several guiding frameworks, which can easily be made relevant to the study of humor. These include the so-called six P's of creativity, the four levels of creative achievement, the notion of idea generation as arising from the combination of different concepts, as well as agreed-upon methods for assessing creativity. Each is now described in turn.

The Six P's of Creativity

One useful organizing theme in creativity research involves the so-called six P's of creativity: the creative person, the creative product, the creative process, the creative place, creativity as persuasion, and creative potential ([Kozbelt et al., 2010](#)). Different lines of research and creativity theories pursue varied subsets of these P's. Depending on a researcher's questions and approach, any of the P's can also be made relevant to the study of humor. For instance, researchers interested in different styles of humor or their relation to well-established personality dimensions will focus on the creative person. Those interested in establishing reliable and valid measurement of humor will highlight the creative product. Cognitive theorists interested in understanding the mental

processes associated with the genesis of a humorous thought will emphasize the creative process. More applied researchers interested in describing or designing environments to optimize humor or creative productivity will prioritize understanding the creative place. Sociologically-minded scholars interested in how new forms of humor arise and take root, or in how humor can be used to facilitate social change, will stress creativity as persuasion. Education researchers interested in identifying untapped creative or humor ability will emphasize creative potential.

Four Levels of Creative Achievement

Another useful framework for understanding creativity concerns the level of a person's creative achievement. A current theory posits four such levels, which progressively build on each other: mini-c, little-c, pro-c, and Big-C creativity ([Kaufman and Beghetto, 2009](#)). As with the six P's, each of these four levels is directly applicable to the study of humor. A mini-c creative episode might involve an individual's brief, private realization about some everyday event that is both humorous and personally novel, which provides a moment of mirth. A little-c extension could involve that person sharing the realization with a friend, having elaborated the basic idea somewhat and giving it a pithy delivery in conversation. If that individual was a professional comedy writer or stand-up comedian, and then used that insight as part of a script or act, this would constitute a pro-c level of achievement. Finally, if that observation became part of the broader culture and was passed down as a comedy classic, it would have become an instance of Big-C creativity. Humorous pro-c and Big-C creative accomplishments in popular culture are most closely associated with superstar stand-up comedians, as well as well-known comic writers, actors, and actresses (See *Comedians*). In the fine arts, Big-C-level humor may be associated with luminaries like Aristophanes, Rabelais, and Twain in literature, with visual artists like Hogarth, Klee, and Steinberg, and classical composers like Haydn, Shostakovich, and Schickele. This roster of eminent historical creators represents another conceptual link between the study of humor and creativity, since the works of such persons are often the focus of Big-C creativity research.

Idea Generation as Conceptual Combination

Another overarching principle in the contemporary study of creativity is a heuristic division of the creative process into two fundamental regimes of thought: one in which ideas are generated and another in which those ideas are elaborated into finished creative products. In many current creativity theories, the process of generating new ideas is the primary engine of creativity and consists simply of combining two or more previously unassociated ideas. These novel conceptual combinations provide the raw material for creative thought, even though most potential combinations are sterile or meaningless. However, the process of combining existing ideas or concepts skirts the thorny issue of where new ideas come from; moreover, theories which assume that such a combinatorial process undergirds creative productivity have shown remarkable accuracy in accounting for phenomena as diverse as patterns of lifespan creative productivity and trans-historical style changes in the arts.

This view of idea generation as a form of conceptual combination is another notable link between established theories of creativity and humor. This is particularly true of incongruity theories ([Suls, 1972](#)) and reversal theories ([Apter, 1982](#)) of humor, in which two contradictory ideas or concepts regarding the same object are held in mind at the same time. When a person engages this process in a playful way, the combinations or synergies are thought to be enjoyable and to increase arousal, as in many situations involving aesthetic appreciation. Despite broad agreement on the importance of conceptual combination processes in humor and creativity more generally, many questions remain unanswered. For example, does punch-line humor involve the simultaneous recognition of incongruous or contradictory viewpoints, or their resolution?

Assessment Issues and Methods

Besides the theoretical links between creativity and humor noted earlier, the two domains also share methodological concerns. Since both creativity and humor can be considered forms of ill-defined problem solving, there is no pre-set correct answer; rather, there is a range of better versus worse solutions. In that case, researchers must have some way of determining which outcomes are more creative or funnier. In creativity research, new ideas or productions are usually assessed by qualified outside raters using survey instruments, along the lines of the Consensual Assessment Technique. Similarly, the quality of humor production is often assessed by having individuals generate punch lines or captions to photographs or cartoons, which are likewise judged for funniness or other criteria by outside raters. Humor quality is also sometimes assessed by mirth response, which involves spontaneous reactive indications of a person finding something funny, like smiling. In both domains, ratings need to achieve adequate inter-judge reliability for the measurement to be useful in distinguishing more creative or humorous instances from those that are less creative or humorous. Ideally, the production task also reflects the way in which such processes play out in the real world, which would yield a valid measure of the construct in question. Because value judgments of creativity and humor are inherently subjective, inter-judge agreement in this line of research is lower than in some other areas of research, where objective criteria of success can be better defined. Despite this, adequate levels of reliability are often achieved in laboratory research studies. This allows the study of creativity and humor to be placed on a reasonably firm empirical footing.

Despite mixed results on aspects of humor and creativity, methodologically exemplary modern studies, like that of [Nusbaum et al. \(2016\)](#), have continued to amass empirical evidence showing fundamental links between the two topics, finding – in this case – positive correlations across a range of humor production tasks, including cartoon-captioning, joke-completion, and

generating definitions for novel noun-noun pairs. These positive correlations suggest that they measured the same underlying humor production ability and that humor ability has much in common with other forms of verbal creativity.

Finally, beyond correlation approaches, and again consistent with links between humor and creativity, several experimental or quasi-experimental laboratory studies suggest that creativity can be enhanced through exposure to humor, training in improvisational comedy, framing a task as humorous, or simple instructions to use humor in completing a creativity task.

Humor Production and Creativity: Issues in Current Research

The previous section detailed some general links between creativity and humor. In this section, several areas of special importance in current research are described, with an eye to identifying promising future directions.

Psychometric Relations

As just noted, assessing either humor or creativity by itself raises significant methodological issues. This is compounded when the relations between the two are examined. Indeed, much research on productive aspects of humor is plagued with methodological shortcomings, sometimes failing to meet standard psychometric criteria of reliability and validity.

Despite such qualms, over the years, numerous research studies have examined the statistical relations between aspects of humor and creativity. For instance, [Feingold and Mazzella \(1991\)](#) found a positive correlation between humor reasoning and performance on the Remote Associates Test, often taken as a measure of creative thought. Other researchers used varied humor production tasks (like generating funny captions to cartoons or photos, or funny campaign slogans), and often found moderate positive associations with various measures of creativity (like Remote Associates or Alternative Uses tests). A meta-analysis of such studies by [O'Quin and Derks \(1997\)](#) found a moderate positive relationship between measures of sense of humor and measures of creative abilities (average correlation = 0.34). Thus, persons with a greater sense of humor also tend to be creative in other domains. Such a relation does not, of course, identify a causal arrow, and indeed, O'Quin and Derks noted that confounding factors like general intelligence could underlie this relation. Other explanations for this association include cognitive processes activating multiple schemas to resolve incongruities in humorous and creative situations or positive affect associated with humor reducing tension and rigidity in thinking and boosting creativity.

Initial forays into the assessment of humor, creativity, and their relations suggest sensible empirical linkages between these conceptually similar constructs, as well as related abilities like intelligence ([Kaufman et al., 2008](#)). Future research would benefit not only from greater conceptual clarity making distinctions between sub-types of humor and creativity, but also by methodological improvements like more diverse samples and tasks, deemphasizing self-report measures in favor of individual-difference performance measures, and treating data in more up-to-date and sophisticated ways – for instance, in using latent-variable and hierarchical regression models.

The Influence of Personality

Much has been written about the creative personality. Research on the standard Big Five personality dimensions and various aspects of creativity has consistently revealed that the dimension of Openness to Experience is much the strongest predictor of creativity; of the remaining dimensions, only Extraversion also sometimes shows a positive association with creativity.

Research on humor and personality is sparser, but unsurprisingly, Openness to Experience and Extraversion are again most frequently invoked as likely correlates. Several studies found reliable positive relations between Openness to Experience and performance on humor production tasks. As with creativity, results linking humor and Extraversion are somewhat weaker and more controversial. Continued research linking personality dimensions to more nuanced aspects of creativity in different domains or different styles of humor would likely represent a fertile step forward on these issues.

Humor and Insight

A prominent aspect of the study of creativity is the phenomenon of insight: an “A-ha!” moment in which a person has a sudden realization of the answer to a problem that they were previous unable to solve. Insight has been explicitly linked to humor – particularly humor comprehension – in that the same kind of mental restructuring thought to occur in creative insights can also explain how people quickly revise a concept in the course of getting a joke. Research on humor comprehension has yielded support for this connection. For instance, when participants are shown cartoons accompanied by either a correct or incorrect interpretation and are asked to say whether a given interpretation is correct or not, right answers are made more quickly than wrong answers, correct interpretations are identified more quickly and those cartoons are rated as funnier than cartoons accompanied by incorrect interpretations ([Kozbelt and Nishioka, 2010](#)).

But humor comprehension is not the only arena for insight-like processes. Given the ability of some people to produce rapid-fire repartee and wit, both in everyday conversation and domains like improv comedy (see Improvisation), something resembling insight seems likely to undergird humor production as well as humor comprehension. Little direct evidence has thus far emerged

on this point. However, some research on humor production has found indirect support for this view; for instance, when participants generate many potentially humorous ideas, many of the funniest instances emerge rather early in the session, which could result from quick associations or from pattern-matching to familiar kinds of jokes in a person's long-term memory. A stronger link between insight and humor production could emerge from studies using a finer-grained examination of the time course of one (rather than many) humorous idea. Alternatively, effective humor production may simply rely less on brief, insight-like mental processes than on more protracted elaborative, metacognitive, or self-monitoring processes – perhaps especially in well-rehearsed stand-up performances or in comedy screenplays, where small changes in wording or timing can make a big difference in perceived humor quality. This set of issues awaits future research.

Humor Production, Humor Comprehension, and Humor Appreciation

Whether or not humor production stems mainly from processes that are brief or protracted, a fruitful approach to understanding humor is to embrace it as an individual-difference ability variable. Clearly, some people are more adept at producing humor than others. Are there other aspects of humor on which such persons show systematic advantages? The clearest evidence bearing on this question concerns the relation between humor production and humor comprehension. It is hard to consistently produce effective humor if one cannot understand it.

Several research studies have shown positive associations between humor production and comprehension, even when comprehension is measured using tasks that have no productive component. Interestingly, humor production ability is usually found not to be correlated with humor appreciation – that is, the subjective experience of finding something amusing (Kaufman et al., 2008). High-quality humor producers may simply have high standards that are unlikely to yield a high humor appreciation score on most laboratory tasks. Notably, available evidence also suggests that humor comprehension is positively correlated with humor appreciation as well as production, despite the observed weak relations between appreciation and production (Kaufman et al., 2008). Refining the relations between these constructs is another avenue for future research.

The Evolutionary Origins of Humor and Creativity

One of the most innovative and contentious aspects of recent humor research involves the question of the origin of the human capacity for humor (as well as for creativity, intelligence, and artistry, broadly defined). How did these capacities emerge? There are several plausible answers. For instance, the ubiquity of humor and laughter among humans might implicate the mechanism of Darwinian natural selection – although this claim yields little information about the particular selection pressures that may have favored humor's evolutionary emergence. Another explanation concerns the capacity for humor to facilitate social bonding, including intimate inter-personal relationships – however, this explanation typically entails a form of group selection, a highly controversial assertion.

Another possibility is Darwinian sexual selection. Unlike natural selection, which focuses on inter-species competition, sexual selection is concerned with intra-species competition. Since females generally must make greater investments in parenting compared to males (and are thus more limited in the number of offspring they can produce), they should be more selective than males in choosing mates, to maximize the genetic quality of their children. Males must thus compete against each other to display indicators of genetic fitness that females will find attractive. In this view, throughout human evolution, an ongoing sexual selection dynamic resulted in complex psychological adaptations like humor, creativity, and intelligence – all of which can be construed as meaningful individual-difference abilities. Indeed, if such differences are stable and have some genetic foundation, this provides the requisite raw material for evolutionary processes to work on.

High-quality humor production has often been regarded as an ability. This individual-differences approach has been adopted by evolutionary social psychologist Geoffrey Miller (2000) (Geher and Miller, 2008), who is the leading contemporary proponent of Darwinian sexual selection applied to higher-level cognition, including creativity, humor, and intelligence. In this view, humor functions as a reliable and valid indicator of genetic fitness, since the ability to produce high-quality humor is difficult and cannot be faked. As the same is true of creativity and intelligence, the sexual selection view implies that all these abilities should be positively inter-correlated, since they all partake of general underlying genetic fitness that confers an aura of “sexiness” on males possessing these characteristics. Indeed, having a good sense of humor is one of the most desired human traits, both socially and sexually. Persons with a good sense of humor are perceived as more friendly, interesting, pleasant, intelligent, emotionally stable, and creative. Using humor also elicits feelings of closeness among strangers and is attractive to potential mates.

Psychometric research has corroborated many of the predictions of sexual selection theory, including positive correlations between humor production, humor comprehension, creativity, and intelligence, as well as sex differences in humor production, with males generally outperforming females in controlled laboratory settings (Greengross and Miller, 2011). Professional standup comedians likewise outperform controls on measures of verbal intelligence, humor production ability, and on each of four well-established styles of humor (Greengross et al., 2012). In addition, research suggests that females prefer males who are adept at producing humor, while males prefer females who are more appreciative of humor (Bressler et al., 2006).

Other lines of research have provided additional converging evidence in support of sexual selection theory. For instance, when females at peak fertility in their monthly cycle are asked to choose between potential mates, the relative desirability of poor but creative men increases; however, this effect is specific to short-term mating (Haselton and Miller, 2006). Miller and Caruthers (2003) found similar short-term-specific effects of increased female fertility regarding females' perceptions of the attractiveness

of men with high humor-production ability. Moreover, in that study, men described as having higher humor production ability were also rated significantly more socially sensitive, adaptable, extroverted, exciting, happy, and able to play well with kids, as well as more intelligent, kind, tall, healthy, masculine, and muscular.

Predictions of such results are unique to a sexual selection-based explanation for the evolutionary origin of humor, compared to other accounts. However, this trait-indicator sexual selection model of humor and creativity is not universally accepted, and several alternative models have been proposed. These include humor as a way of signaling shared knowledge and compatibility, humor as an interest-indicator that allows individuals to test the reciprocity of romantic interest, and humor as a way to signal advantageous parental qualities, such as warmth and prosociality. Despite – or because of – this lively debate, it seems likely that sexual selection will remain an important theoretical framework informing the study of various aspects of humor as well as creativity more generally.

Conclusion

The preceding examples illustrate the range and depth of links between humor and creativity that have been revealed by psychological investigations. Historically, research on these two topics has run in parallel, with only minor overlap and attempts at synthesis – though recent research suggests this may be changing. At their best, treatments of humor and creativity are mutually informative and supporting, broadening and deepening our understanding of human psychology and culture. Moreover, besides the basic scientific benefits of such a synthesis, synergy between the two would also work toward redressing the historic reality of both topics being ‘orphans’ within psychology. Humor and creativity are topics of great popular interest and importance, remain methodologically stimulating for researchers, and have longstanding and copious research literatures. Despite all this, arguably neither area of scholarship is typically given comprehensive (or even adequate) coverage in introductory textbooks and many prominent journals. Humor researchers and creativity researchers are thus allies in the struggle for recognition, as well as the scientific struggle to learn about their respective (and overlapping) research areas – both perennially fascinating domains of human activity.

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Hyperspace

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Introduction

The word “hyperspace” refers to a realm with more than three dimensions. Merriam-Webster added another definition in reference to the popular culture: “a fictional space in which extraordinary events happen.” Creativity is about being and doing extraordinary, but the pathway to the extraordinary, which is the creative process, is probably the least known aspect of creativity. The creative personality is, for example, much more often described in the literature. Yet an authentic explanation for creative achievement must include the underlying process. Without a description of the underlying process, theories of creativity lack explanatory power.

Hyperspace is a concept that [Acar and Runco \(2015\)](#) borrowed in their theory of the creative process. It extends the theory of divergent thinking and allows empirical testing. The term hyperspace was first applied to the creative process in the following:

Divergent thinking can take ideation in all directions. Depictions probably are inaccurate because they are two-dimensional, in which case ideation can only move along the abscissa and ordinate. Ideation can go anywhere, in any of the 360 degrees. This is still a simplification; surely for truly creative thought, three dimensions would be necessary. In fact, given the possibilities of the human mind, what statisticians and science fiction aficionados sometimes call *hyperspace* (with dimensions more numerous than three) ... Each of these [dimensions] implies a unique and perhaps orthogonal dimension for ideation

[Runco 2010](#), p. 19.

This entry explores the philosophical and conceptual foundations of the concept and revisits relevant theories of creative personality. Then it summarizes the empirically tested model of hyperspace categories.

Philosophical and Conceptual Bases

Hyperspace could be visualized as a set of multidimensional continua where each continuum consisting of polar opposites. The idea of opposites has long intrigued philosophers who in many ways influenced modern day psychology. Socrates believed things emerge from their opposites, for example, and the term “dialectics” refers to the method of developing philosophical arguments drawing from contradictory opinions from two opposing sides. The refinement of philosophical arguments may require such an oscillation from one pole to the other. Hegel further delineated this idea with *dialectical materialism* which moves from thesis to antithesis to synthesis. The generation of superior forms of thinking, the synthesis, depends on a thesis and its (opposite) antithesis.

Theories of and research on creativity in modern day psychology are rich with complementary polarities. Even the definition of creativity seems to be having some polarity, at least in the findings of [Runco and Charles \(1993\)](#) that there was inverse relationship between originality and appropriateness in ratings of creative ideas. Divergent and convergent thinking also implies a polarity, and both are involved in successful creative outcomes. Bruner’s “effective surprise” fits here as well: The novelty required for creativity is associated with a feeling of surprise because of the fit or effectiveness. Basadur’s ideation-evaluation cycles is similar for it describes a ratio of ideation-to-evaluation that can predict creative work. Campbell’s model of blind or wide variation and selective retention is another polarity that represents inductive, generative, and branching out nature of creative process followed by elimination and selection. These may sound antithetical but they are both involved in creative efforts. More recently Allen and Thomas distinguished Type 1 from Type 2 thinking, with automatic and fast thinking (Type 1) separated from effortful and logical thinking (Type 2). Another recent theoretical distinction is the dual pathway theory that views successful creative process as involving cognitive flexibility and cognitive persistence. According to this theory, creativity benefits from generation of a variety of categories and clusters as

a result of flexible cognition as well as exploiting each cluster to the fullest, which is facilitated by persistence. An especially intriguing and relevant theory is that of *Janusian thinking*, which is defined as the ability to simultaneously see, imagine, or utilize two contradictory or opposite thoughts, ideas, solutions (see Janusian, Homospatial and Sep-Con Articulation Processes).

Some relevant polarities are not entirely cognitive. Kirton's Adaptation-Innovation approach, for instance, reflects a polarity with two *styles* of creativity. The adaptive style is indicated by efforts at being precise, methodical, orderly, and favoring incremental change. On the other end of the continuum is the innovative style, which is more chaotic, non-linear, disruptive, and prefers radical change. Kirton's distinction seems to be aligned with Hitt's distinction of original thinking versus logical. Hitt called this "two-factor theory of creativity." Long before this work, creativity research borrowed *primary* versus *secondary process* thinking from psychoanalysis.

There is also a view that the creativity resulting from polar opposites is not simply a cognitive skill and process but is more realistically viewed as a reflection of personality (see Paradoxical Creativity). The next section discusses these theories of the creative personality.

Theories of Creative Personality

The creative personality is typically described as independent, autonomous, non-conformist, unconventional, challenging of authority and the status quo, open to change and experiences, flexible, and curious. Creative people tend to exhibit such traits more often than others, but they do not do so under all conditions. There is variation. Barron (1963), for example, described the creative personality with such polarities: "The creative person may be more primitive and more cultivated, more destructive and more constructive, occasionally crazier and yet adamantly saner, than the average person" (p. 234). May (1975) pointed to rigidity vs spontaneity as another polarity, and Maslow (1971) referred to the management of dichotomies, drawing from psychoanalysis and including the conscious vs unconscious and primary vs secondary processes.

Some scholars have listed the common opposites of creative individuals. Torrance and Hall (1980) listed masculinity versus femininity, conformity versus nonconformity, independence versus dependence, serious versus playful, timid versus bold, certain versus uncertain, and receptive versus self-acting. Such a view of creative personality became particularly popular with Csikszentmihalyi (1996) who coined the label the "complex personality." He described creative people as a) having high energy while also being quiet and taking rests frequently, b) smart but naïve, c) playful and yet disciplined and responsible, d) resorting to both imagination and fantasy while staying connected with reality, e) extroverted and introverted simultaneously, f) humble but proud, g) masculine and feminine, h) traditional and conservative while rebellious and iconoclastic, i) objective but passionate, and j) experiencing suffering and pain as well as joy. Csikszentmihalyi argued that one pole helps with "novelty" while the opposite is useful for "acceptance." Truly creative people can use both and, as a result, often become famous for their creative accomplishments.

Csikszentmihalyi (1996) acknowledged that this list is somewhat arbitrary and there may be other dimensions to add. In fact, in a later study Gute et al. (2016) mentioned an agency-communion dimension. This was suggested by their qualitative analysis of Jazz Pianist and Composer Oscar Peterson's creative personality, which also included introversion and extraversion. They argued that classic measures of personality (e.g., the Big-5) fail to identify polarities. Oscar Peterson was both an introvert and extravert. He was an introvert to differentiate himself from others, making him more unique in his domain and allowing him private listening, solitude, and introspection. Once inspired his more natural extraverted side would emerge to integrate his work to the larger world of music through public performance. This cycle of differentiation–integration is a consequence of a pursuit of flow-seeking nature of people with a complex personality.

An early but more structured formulation of complex personality of creativity came from W. Ed McMullan's (1976) work. McMullan's conceptualization emerged from a review of studies that attempted to identify traits that distinguish highly creative individuals from others. Those studies provided contradictory adjectives describing creative individuals. McMullan concluded "the creative person may more closely resemble two thinkers in tandem than one fully integrated being" (p. 266). Because of this nature of creative individuals, he called them "paradoxical personages."

Drawing from May (1975) and Maslow (1971), McMullan also viewed creativity as a polarity between flexibility and persistence. Significantly, these two terms are the exact same terms later used in the *dual pathway* theory of creativity. McMullan argued that flexibility provides freedom, which is critical for creativity, whereas persistence leads to the refinement and feasibility of an idea or solution. He viewed "flexible persistence" as a central trait of creative individuals, which unfolds to eight components: 1) delayed closure, 2) converging divergence, 3) mindless perception, 4) constructive discontent, 5) detached involvement, 6) disinterested selfishness, 7) confident humility, 8) relaxed attention. *Delayed closure* describes creative judgment where the creator keeps an open-mind and prefers complexity but must eventually reach a conclusion or finalize the process with some sort of closure. *Converging divergence* reflects the reasoning process that incorporates de Bono's lateral and vertical thinking, or divergent and convergent thinking, where the former brings novelty and the latter feasibility. *Mindless perception* describes the process in which a creative individual loses oneself in the present through an experience of self-transcendence (see "Flow"), but then brings the experience to consciousness through deliberate and controlled thinking processes. *Constructive discontent* is related to the attitude toward the outcome describing creative individuals' inclination to use positive and affirmative attitudes toward novelty while taking a disruptive attitude against established norms and structured. *Detached involvement* portrays an emotional state of creative individuals which indicates deep immersion in the process of creative activity but can also provide objectivity about the final outcome. *Disinterested selfishness* refers to the motivation of

creative individuals who are both self-centered and in service of greater good for all. Creative individuals' self-concepts are also paradoxical in that they blend humility with confidence. *Confident humility* represents the feelings of self-sufficiency to solve complex problems and accomplish great things accompanied by the feelings of humility in the face of greatness of the external world and smallness and ignorance against it. The last dimension is *relaxed attention* describes creative individuals as on the task with great deal of energy without irrelevant tension.

McMullan connected flexibility to a humble self-concept, disinterested motivation, discontented attitude, mindless perception, divergent thinking, relaxation, delay in closure, and emotional involvement. Persistence was connected to confidence, selfish motivation, constructive attitude, conscious processes, convergent thinking, attention, systematic closure, and emotional detachment. These things reflecting flexibility are more involved in idea formulation whereas persistence allows idea elaboration.

Polarity in Practice

Polarities are useful to recognize in practice. Johnson (1992) viewed polarity management as a critical strategy for "dilemma-solving" in organizations. According to this model, most challenges facing people are not problems where there is a goal but also an obstacle, but dilemmas, and failure to recognize the distinction between the two creates new problems while solving one. According to Johnson, life is full of polarities such as individual versus group, cost versus quality, innovation versus standardization, and individual creativity versus group cohesion. Emphasizing individual creativity may lead a person or group to further encourage individual work, which after a while, may undermine unity, cohesion, collaboration, and lead to a destructive competition. Once this is recognized, the individual or group may find a balancing, with group cohesion harvesting some of its advantages and leading to a stronger preference for group cohesion. There could be more social loafing, loss of individual risk-taking, and lack of personal initiative. Individuals or organizations should be able to recognize the polarities and should steer appropriately when needed.

Puccio (2017) extend this principle to creativity, which he viewed as the antithesis of conformity. He argued that creativity alone does not explain human civilization. Creativity is accompanied by conformity and their co-existence help advance the society. This argument is not far from the idea of personal *discretion* to be creative (see "Personal Creativity" in this volume). Success of a creative activity is most effective when it is deliberate, and people should know when to be creative and when to delay it.

Polarity management takes a value-neutral perspective between the two extremes. This is different than the more common "either-or" thinking leading people to favor and adopt one of the two options over the other. Again, drawing from philosophy, Dewey promoted "both/and" thinking because better solutions lie between the two extremes and in their synthesis. Reflecting the spirit of this trend, recent literature pointed to the positive role of routines and conformity, which used to be perceived as the enemies of creativity in some literature. Miron-Spektor and colleagues (2011) tested if integration of contradictions improves creativity. They found that paradoxes were more appealing to creative individuals and paradoxical structures lead to tension, which in turn motivates people to integrate the contradictions. Consequently, creativity increases with the use of paradoxes and integration of contradictions.

This review described how contradictions, polarities, and the hyperspace containing them is related to creativity. Another area where polarities and the complex personality must be recognized is that of creativity assessment. The next section will discuss an application of polarities to divergent thinking, which is a popular method for the assessment of creative potential.

Literal Divergent Thinking

Acar and Runco (2015) integrated polarity perspective into divergent thinking with special focus on its very definition. Divergent thinking is defined as thinking in many different directions (see "Divergent Thinking"). Not one or two, but in many different directions. The word "diverge" implies ideas branching out from a single point, question, problem, or challenge but assessment of divergence was not really assessed. Acar and Runco used above summarized theories of personality and applied it to the evaluation of divergent thinking tasks. This approach is notably different than the traditional approach scoring responses to divergent thinking for fluency, flexibility, originality, and sometimes elaboration. Those indices do not really reveal pathways or processes to creative solutions, but rather focus on the outcomes of ideational process. The idea behind the literal divergent thinking is to capture directions followed in the ideational processes. If ideas diverge from a single point to multiple directions, the way branch out may be captured and those who use more directions would be performing higher as they literally think in a divergent way. The model involves multiple dimensions with each dimension with two polar opposites. Acar and Runco (2015) revisited the theories of creative personality and attempted to build a model of *hyperspace* involving multiple dimensions where each dimension is formed by two opposites.

Hyperspace Categories in Divergent Thinking

It is not difficult to find polarities with relevance to creative thinking and the creative personality. Some of the polarities mentioned above may be conceptually and theoretically meaningful but not be operational and may not be captured empirically. Acar and

Runco (2015) identifies polarities that are both theoretically and conceptually relevant and could be captured as objectively as possible. Here is their list, with 11 dimensions with thus 22 polarities:

1. Originality vs. conventionality
2. Taboo, unethical, malevolent, amoral, illegal (TUMAI) and vs. Nontaboo, ethical, moral, benevolent, & legal (NEMBL)
3. Primary vs. secondary processes
4. Experience vs. nonexperience
5. Functional and practical vs. impractical, aesthetic, and
6. Synthetic vs. nonsynthetic
7. Breadth vs. depth
8. Feasible, realistic, & possible vs. infeasible, hypothetical, & unrealistic
9. Natural vs. unnatural
10. Humorous, playful, childlike, vs. serious, sober spontaneous vs. mature & responsible
11. Close vs. remote

Each of these dimensions was used in research drawing from ideas given to various divergent thinking tasks. Admittedly the results only represent the one sample, but this research does indicate that hyperspace can be examined empirically. Perhaps most important were the categories used to operationalize hyperspace. These are interesting independently of the data from the initial investigation. Here is a detailed summary of the dimensions and the method for scoring ideas using them.

1. *Originality vs. conventionality*: This dimension is about novelty and frequency of responses in divergent thinking, each of which is important because originality is a must for creativity. Empirical evidence clearly indicates that the closest associate of creativity is originality. However, creative people are not just original thinkers. They have to find a way to make the raw original ideas better, complete, and refined through evaluative and convergent thinking processes. Refinement and evaluation often benefit from common sense, conventions, standards, and goals. Therefore, routines and conformity are not necessarily the enemies of creativity. They could play a critical role in the acceptance and communication of the solutions. As a result, one would expect both original and conventional responses in divergent thinking process of creative individuals. Acar and Runco (2015) operationalized this dimension of hyperspace using an established method which relies on frequencies. Statistically infrequent responses were considered original and all others were conventional.
2. *Taboo, unethical, malevolent, amoral, illegal (TUMAI) and vs. Nontaboo, ethical, moral, benevolent, & legal (NEMBL)*: The focal point of this dimension is beneficence and social approval. Creative thinkers have on occasion been described as contrarian and psychotics who do not limit themselves to socially acceptable responses or solutions. Their ideational repertoire is wide and rich with many types of thoughts, some of which may be destructive, disruptive of established systems, chaotic, malevolent, illegal, or amoral. The fact that they do not censor themselves from thinking such a way could be a proof of their creativity because, as noted above, creativity is about thinking without limits. However, creativity is not all abnormality or anarchy. Creative thinkers may channel their divergent thinking to constructive, benevolent, legal, and morally acceptable outcomes. Therefore, one could find both types of ideas in their responses to divergent thinking tasks. Acar and Runco (2015) identified responses that were destructive, aggressive, and involving sexuality, or magical ideation. Sexuality, aggression, and magical ideation could often be viewed as taboo. All other responses were considered nontaboo and legal.
3. *Primary vs. secondary processes*: This dimension is related to the involvement of consciousness. As was previously discussed, creativity is often associated with primary processes because of its connection to the unconscious. This may help with creative solutions, especially during incubation. Primary thinking processes involve automated, fantasy-oriented, crude, dream-like, and immature that let ideas freely flow. Such as process need to be followed by secondary processes where ideational freedom is filtered by logical, sophisticated, and goal-oriented thinking. To score the responses to divergent thinking tasks, Acar and Runco (2015) used Colin Martindale's *Regressive Imagery Dictionary*, which consisted of words and concepts associated with primary and secondary processes.
4. *Experience vs. nonexperience*: This dimension is about the individual's use of memory. Remembered experience is a good source for ideation because past experiences will provide some easy solutions to some problems. Memory enhances fluency because it provides ideas, but it may also help with originality because some experiences are unique or may only be retrieved by some people. However, creative people can also go beyond their memory and past experiences and use their imagination and explore the hypothetical. It likely that imagined solutions will be more idiosyncratic than experienced solutions. It is also important to keep in mind that imagination and memory are not mutually exclusive. Imagination may be rooted in memory and experiences. The distinction between inexperienced or imagined and experienced responses was explored in previous research. Participants were able to reflect on their responses and indicate which are experienced and which are inexperienced. Thus, this dimension was scored by asking participants which of their own responses to divergent thinking tasks they had themselves experienced before.
5. *Functional and practical vs. impractical, aesthetic, and artistic*: This dimension looks into the practicality of the solutions. Things may be creative because they are aesthetic and artistic or they may be deemed so simply because of their functionality and practicality of the solutions. Creative things may resemble one or the other category, and sometimes they resemble both. One reason why design thinking became popular in creativity and innovation process is the desire to achieve both. A creative product is successful to the degree they are functional and appealing to the customers. Aesthetic and artistic aspect may help

with having an emotional connection with potential buyers while functionality and practicality will actually sell it. [Acar and Runco \(2015\)](#) evaluated each response in terms of level of pragmatism. Pragmatic uses represent the functional and practical uses of objects whereas non-pragmatic responses were for considered impractical, aesthetic, and artistic.

6. *Synthetic vs. nonsynthetic*: This dimension deals with complexity of the responses. Preference for complexity and ambiguity is among essential traits of creative people. For example, the focal point of Barron-Welsh test is to see if people embrace or avoid complexity in some drawings. Ideas may also be simple or complex and [Acar and Runco \(2015\)](#) distinguished the two by looking at the synthetic nature of the responses. If an idea combines two or more ideas, it was considered synthetic.
 7. *Breadth vs. depth*: Sequentiality is also informative to understand the processes involved in divergent thinking. The open-ended nature of the tasks allows following a consistent, predictable, linear pathway, or they could jump across distinct responses. The former is ideational progress in a vertical direction, so was called depth, while the latter refers to ideational progress in a horizontal direction, which is breadth. It may be best when people do both because jumping across categories reflects cognitive flexibility and avoidance from fixation while exploiting any single category to the fullest signifies persistence. [Acar and Runco \(2015\)](#) tracked down the sequential patterns in the responses given for divergent thinking tasks. When a subsequent response is a continuation of the preceding response semantically or categorically, it was labeled as “depth.” When there was a departure between two consecutive responses, the succeeding response was labeled as “breadth.” This method of scoring is closely aligned with scoring verbal flexibility in Torrance Tests of Creative Thinking (TTCT) based on “shifts.”
- A later study by the same researchers found that latency—the time that elapses between two adjacent responses—might predict the probability of a category switch (breadth). Latency was 5 s longer with the instances of breadth than depth. Latency took about 2.5 s longer with figural divergent tasks than the verbal ones. In a more recent study, latency also predicted originality when it was scored based on semantic networks, which assesses original as conceptual distance from the prompt. Those studies indicate that both responses to divergent thinking tasks and the process of generating them provide useful data about the dynamics of creative thinking process.
8. *Feasible, realistic, & possible vs. infeasible, hypothetical, & unrealistic*: Workability of solutions is another dimension to diverge between two poles. Some responses may be realistic, feasible, and possible while others could be just hypothetical or unrealistic. There would be limited creativity had people think within the limits of existing conditions and possibilities. Personality traits such as risk-taking and strategies like challenging assumptions may gift creative thinkers the opportunity to explore what is yet to be possible. Creative people often do that naturally, but they are still based in reality. [Acar and Runco \(2015\)](#) scored responses to divergent thinking tasks as infeasible, hypothetical, and unrealistic if they are not possible under the current conditions.
 9. *Natural vs. non-natural*: The nature of objects considered in the responses to divergent thinking tasks is another point of divergence. Surrounded by man-made objects, people may find them easier to retrieve, but natural objects may expand their ideational spectrum. The scoring procedure distinguished responses involving man-made objects from natural objects.
 10. *Humorous, playful, childlike, & spontaneous vs. serious, sober, mature, & responsible*: The responses to divergent thinking tasks may reflect the mindset. New, unusual, and flexible ideation may certainly benefit from playfulness, humor, naivety, and spontaneity while they may need to be complemented by some level of solemnity and maturity. The scoring determined responses involving playfulness and humor and labeled them as different than the rest.
 11. *Close associations vs. remote associations*: The final dimension is concerned with the distance of associations made based on the divergent thinking prompt. Most people can make common associations whereas creative people could make remote associations (see “Associative Theory”). However, making only remote associations may be indicative of lack touch with reality. Some too distant responses may be irrelevant. [Acar and Runco \(2015\)](#) identified remote associations by using associative networks from WordNet, Word Association Network, and IdeaFisher, which provided lists of associations for the divergent thinking prompts. Responses that did not use any of the concepts in the associative network were considered remote associations while those using them were close associations. They found that such as metric is related to creativity attitudes and values.

Acar and Runco tested the usefulness of this set of hyperspace dimensions using reliability analyses and concurrent validation. They administered 3 verbal (i.e., Many Uses) and three figural divergent thinking tasks and scored responses to each one for the applicable dimensions. Some dimensions were not applicable to certain tasks. For example, remote versus close associations were not scored for figural divergent tasks. Scoring involved counting how often a hyperspace category was used for each prompt. The sum of hyperspace category counts constituted the literal divergent thinking score for each participant. This score proved to be quite useful and had a significant association with originality.

Conclusion

Hyperspace is a useful framework to understand and conceptualize the process of creative thinking. One way to study hyperspace involves polarities. This is an especially good way to study hyperspace because decades of research underlines the importance of dealing with opposites and polarity in thinking for creativity. Clearly, this framework is well-situated on the conceptual and philosophical foundations and relevant theories of creative personality support it. This entry elaborated a specific application of hyperspace to divergent thinking. Hyperspace is a novel approach to score divergent thinking tasks in several ways. First, it focuses on the

processes involved in ideation. Second, it truly reflects “divergence” and hence is consistent with the very definition of divergent thinking. It captures a kind of divergence—literal divergence—that typical applications of divergent thinking tests does not. Third, it is highly operational compared to the frameworks of complex personality traits. Fourth, it is an integrative approach covering a wide variety of theoretical and conceptual bases. However, it has certain limitations, too. For example, the dimensions may further be expanded to others such as “abstract vs. concrete.” Second, some dimensions (e.g., close vs. remote; primary vs. secondary; originality vs. conventionality) are more objective than others in terms of scoring, which allow automated scoring. Third, scoring divergent thinking tasks for 22 dimensions is laborious. Future research may focus on a revised version of the hyperspace categories that are both extensive and highly objective.

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Idea Density

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Idea Density

Idea density (ID) is a well-known psycholinguistic measurement method to study the processes in language. ID separates words and sentences from the conceptual meaning in the text and analyzes the density of ideas in written or oral works. An ID score is calculated by dividing the total number of verbs, adjectives, adverbs, prepositions, and conjunctions in a work by the total number of words. ID is important to as it allows creativity researchers to study the relationships between ideas, language patterns to present those ideas and creativity.

ID formulates both linguistic and technological approaches to reveal how people express their creativity in written or oral works. Writing reveals insights into their author's personality, education, background, culture, and psychology. The ways that authors introduce and explain ideas, connect them to each other, and their word choices all say something about them. Many psychologists and government bodies use writing samples to unveil details about the person and to understand their psychological nature. Forensic and historical detectives use writing to situate authors and their work leading to clues about their lives and mindset. Like fingerprints, authors and their writings are unique. However, the languages that authors follow patterns of speech and people learn to set up their writing according to these patterns. These patterns begin in preschool and continue to be developed throughout the education system creating writers that use these patterns of speech even if they don't recognize them as such. ID helps researchers formulate ways to study people's writings in order to learn more about their ideas. By parsing out the density of ideas, ID studies the core thoughts and thought processes beyond the text on the page.

Some authors make elaborate sentences with flowery, wandering language. Some authors are succinct and direct. Some people show their emotions, while some do not. The impact of the word choices counts when it comes to writing. You may see hundreds of pages notes on one topic, but in those hundred pages only a handful of ideas are presented. Alternatively, you may see two pages of text that is laden with ideas. ID comes to the play here to distinguish the different level of densities of ideas in written works. In this example, the hundred pages work may have the same or even fewer ideas than the two pages work.

Creativity happens in verbal and non-verbal ways, but when authors talk about creativity it is verbal. In a soccer game there are certain words or phrases used to describe what is going on during the game: *pass*, *run*, *defense*. A soccer commentator can talk for hours by only using few words to describe the movement and creativity of the players during the game. Similarly, an artist employs creativity in a number of ways, but when that art is discussed by others there are certain words or phrases used to describe the work: *aesthetics*, *abstracted*, *vivid*. In both the soccer and art commentaries, authors express their creative ideas with using a few certain words or phrases according to Turkman and Runco's (2019) study. For example, using *however* means that a person is going to

make a counter argument to explain something different than usual situation. *However* is a cue that the person is going to bring a different perspective to the situation. In the soccer example: Player A has a great record with free kicks, *however* he is returning from surgery and may not be at his best. In the artwork example: Artist A is an excellent watercolor artist, *however* she has recently been experimenting successfully with sculpture. Turkman and Runco (2019) revealed the relationship between language and creativity by focusing on how people use these kinds of keywords to introduce their original ideas.

ID helps us to determine the conceptual meaning underlying text as the superficiality of the words and sentences are separated from the conceptual meaning in the text. It is a mathematical way to quantify ideas and make the quality of the work tangible to understand what ideas exist beyond the sentences. When you are happy you use different words or gestures to show what you feel. When you are sad you use completely different words or gestures to express how you are feeling. During this process different psychological and physical factors involve our language and our bodies to express our ideas or feelings. In English there are only 26 letters. Authors present their ideas and themselves by using these 26 letters. Some earn a Nobel Prize by using these 26 letters; while some fail their final exams using the same 26 letters. What is important here is how authors communicate ideas and the creativity of those ideas.

The Background of Idea Density

In the 1960s Walter Kintsch, a psychologist, began working to understand how people encode and decode written texts. In this framework, authors encode meaning into written text and readers decode meaning from the written text. Kintsch's work was influenced by the earlier work linking the perceived difficulty of a text to its readability and communicability. In 1973 Kintsch and Keenan found that the propositions in a text influenced the reading rates and the encoding and decoding processes of the text and published what would become the foundations for the Idea Density, or ID, theory.

Ideas and Propositions

Turner and Greene later used Kintsch and Keenan's (1973) propositions or "representations of conceptual units" (1977, p. 4) where the proposition itself represents a concept that is more than the words used in the text. At first an idea is pre-positional because it exists in the mind of the author alone. The idea becomes propositional once language is employed to describe it. For Kintsch, language is the expression of thoughts made at this propositional level and Kintsch was deeply interested in how to understand the psychological representation of meaning (Thorson and Snyder, 1984). Turner and Greene (1977) formed a methodological framework for this representation of meaning by using propositional analysis. For example, the sentence: *The young brown dog has very large ears* contains 5 propositions:

1. Has/dog/face: *The dog has a face.*
2. Young/dog: *The dog is young.*
3. Brown/dog: *The dog is brown.*
4. Large/ears: *The ears are large.*
5. Very/large ears: *The ears are very large.*

Propositions are conceptual units that are independently true or false. The dog may be young, but may not be brown. Likewise, the dog may not be young, but the dog may be brown. An ID value of the example sentence is determined by the number of propositions divided by the total number of words in a text (Kintsch, 1974; Turner and Greene, 1977). To calculate the ID value, the propositions in the sentence are divided by the total number of words in the sentence leading to an ID value = $5/9 = 0.55$. As measure of quality, ID value determines the efficiency with which ideas are explained. That is to say that any additional descriptive elements or qualifiers about our dear dog would count as additional propositions, but the additional word counts balance out the overall rating so that excessive or flowery language does not increase the ID value. It is also important to note that ID propositions do not include common nouns, verb tenses, modality, or co-references (Kintsch, 1974).

Propositional analysis and ID values have been replicated in various studies. Covington conducted a study where text documents about the same news event were analyzed for ID value and then comparisons were based on the genre of the news type (2009). In the Covington study there were four genres: Popular, Introductory, Scholarly, and Technical divided by the intended audience for the reporting. Popular news sources included news outlets such as Bloomberg and USA Today. Introductory sources included Wikipedia and other blog-style entries. Scholarly sources were those written for academia and Technical sources were written for policy makers. Covington contributed to the development of a computer analysis program called CPIDR to find that both popular and introductory sources had ID values of less than 0.5, while the scholarly sources hovered around the 0.5 mark and all the technical sources exceeded 0.5 meaning that these technical sources presuppose the audience knows a great deal about a specific topic and therefore, these authors can immediately and compactly present ideas. Compared to a popular or introductory source that must first explain basic ideas to a general audience before introducing new ideas, the technical authors can be more succinct and efficient in their presentation of ideas (Covington, 2009). Propositional analysis and ID values are promising tools for evaluating texts and from Covington's study it is evident that the same information presented in different ways for different audiences is communicated with different levels of ID.

Computerized Propositional Idea Density Rater (CPIDR)

The CPIDR (pronounced “spider”) program was developed to make part-of-speech tagging analysis feasible for research purposes. With the development of CPIDR, the laborious counting system to determine ID value was alleviated and currently CPIDR5.1 is available to the public for ID value calculation. CPIDR provides the originality level for thousands of pages of written works in seconds, rather than weeks or days.

With the help of programs like CPIDR, Kintsch’s ID value method one of the most widely used validated systems in psycholinguistic research. ID is more than a theory of semantic logic; rather ID is a theory of how our minds process information. Kintsch’s system has helped researchers go beyond the text and study the cognitive processes in making that text. Assessing the density of ideas contained in a text has potential to further the way researchers evaluate creativity. The CPIDR program makes Kintsch’s method of analyzing language easier. It automatically finds all the prepositions in the text and divides it by the total number of words rapidly calculating the ID of thousands of different texts. Creativity researchers are aware that the ability to generate original ideas is critical to creative thinking and creativity researchers have developed many ways to assess creative products and extrapolate creative potential from the creative product. For example, the Consensual Assessment Technique, or CAT, developed by [Amabile \(1982\)](#) does just that by asking participants to create products that are then assessed by experts in that field. This product-centered approach and the extrapolation of creativity parallels the text-centered approach of ID and the potential of ID to extrapolate creativity as well.

Idea Density and the Cognitive Processes of Creativity

The studies about cognitive processes related to the generation of ideas come from a number of disciplines signifying the broad interdisciplinary nature of ideation and the study of creativity. Cognitive reserve, divergence, and memory, mental leaps, and semantic distance originated in cognitive studies. ID offers a new approach to assessing creativity by using cognitive research creating a theoretical foundation for ID as a research method.

Idea Density, Cognitive Reserve, and Divergent Thinking

ID has been used a measure of cognitive “reserve” ([Stern, 2002](#)), which is to say that people with higher levels of cognitive reserve process tasks more efficiently than their counterparts. Stern noted that high cognitive reserve individuals often test with higher intellectual capacity and educational or career achievements, and that these individuals can cope with higher levels of brain damage (i.e. dementia) before exhibiting any functional decline (2002). In fact, in a longitudinal study lower ID scores as a young adult were proven to be precursors for dementia later in life ([Snowdon et al., 1996](#)). Stern described cognitive reserve as “the ability to optimize or maximize performance through differential recruitment of brain networks, which perhaps reflect the use of alternate cognitive strategies” (p. 451) and this aligns with the work of creativity researchers—particularly those researchers using Divergent Thinking, or DT, tests to assess creative potential. In a DT test a participant responds to open-ended questions to measure the ability of a participant to think in novel and original ways. DT tests have been the “backbone” of creativity assessment for decades and creativity researchers continue to value the data and analyses of these tests because they provide some understanding of how those ideas are formed and particularly how the brain works in the formation of these new ideas. DT tests aim to capture the quality of the divergence of the responses. Furthermore, DT responses are scored on flexibility, fluency, originality, and elaboration as the assessment is aimed to determine the quality of the ideas and their divergence from typical responses. There is a relatively higher correlation between originality and fluency in DT meaning that when people have more ideas, the potential of having original ideas are higher. Like DT, ID is aimed to distill the quality of ideas parsed from the complexities of the sentence structure and language. Both measures are trying to understand how creative ideas are generated and both measures value the quality over the quantity. Idea density, cognitive reserve, and DT all garner the efficiency of a participant to generate creative ideas and this is important to the study of creativity as creativity thrives on ideation.

ID and Working Memory

Memory and the ability to recall information are integral to the cognitive processes in generating ideas as well. [Ericsson and Kintsch \(1995\)](#) proposed that working memory is comprised of the well-known short-term working memory (STWM), but added the component of a working memory linked to long-term memory, which they called: long-term working memory (LTWM). This LTWM is memory that available in a space between long-term memory and short-term working memory and LTWM is initiated by retrieval cues during a task. It had been proven that ID determined the amount of work a reader had to do in order to read a text, but that if the reader were familiar with the domain of the content of the work, the ID has less influence on reading rate ([Miller and Kintsch, 1980](#)). Ericsson and Kintsch found in their 1995 study that there were differences in the LTWM of skilled and unskilled readers in reading span tests. While both groups utilized the capacity of their STWM, the skilled readers were also able to access their LTWM of the domain, thereby expanding their total working memory. This expansion of the concept of a working memory and the macrostructures and microstructures of working memory’s composition are important factors when determining the cognitive processes in generating ideas, particularly in generating original ideas. [Kellog \(2001\)](#) found that the ideas of STWM and LTWM were also evident in the writing of text. In the acts of both reading and writing of text people are accessing more of our

minds than our STWM to translate and conceptualize the words—people are conceptualizing the words based on our experiences with them enlisting our LTWM with that domain.

ID and Mental Leaps

As new ideas are conceptualized there is a reliance on memory in many ways and the information individuals have experienced in the past influences these new ideas. [Thorson and Snyder \(1984\)](#) used the ID propositional structure of advertisements to evaluate which ads were better remembered—better coded—by participants in terms of the quantity of ideas, the information retained from the ad, and the use of branded or descriptive words a day after viewing the ad. Their ID-based “Ad Language Model” successfully linked the propositional structures of the advertisements to improved recall of the ad messages. Understanding how ideas are encoded into memory structures and how ideas are expressed is of vital concern to creativity research and ID offers an approach to discover these relationships and processes.

Ideational pathways, including divergence, memory activation and recall as previously mentioned, have drawn the attention of creativity researchers. There are a few lesser-known conceptual models for ideation in creativity. E.P. Torrance is one of the pioneers of the mental leap concept in creativity. [Torrance \(1995\)](#) defined the ability to take mental leaps as an important aspect of DT as they demonstrate the resistance to premature closure. [Turkman and Runco’s \(2019\)](#) study also investigated cognitive processes in the associative processes taking place in DT by focusing on how semantic distance is related to traditional flexibility scores. As originality and appropriateness are two important defining factors of creativity, the identification of the relative distances of these ideational pathways’ in our cognitive process is important to determine if the idea fulfills the originality and appropriateness criteria. In other words, a very far distance of ideational pathway might represent an unrelated and inappropriate idea.

Idea Density and Keywords

Significant relationships have been found with regard to creativity as in [Turkman and Runco’s \(2019\)](#) study investigated keywords—the common words and phrases that are used to introduce original ideas—and compared the density of keywords in a work to the ID in the work.

Keywords are the specific words and phrases that are used with regularity when people introduce a new idea. Remember the example, however that typically introduces a counter-argument and therefore an idea. Experts created and compiled a list of words found in various oral and written works. Upon reaching a consensus the final list contained 17 words that the experts identified as keywords most often used to introduce ideas. Some keywords introduced an original idea, while other keywords introduced a contradiction or possibility (e.g., “possible”, “would be”). The keywords were coded into a computer algorithm and the oral and written works were analyzed for their keyword usage. The statistical analyses indicated that the keywords successfully identified original ideas in written works and speeches. This study revealed general tendencies and a set of particular keywords that are used with regularity when people introduce a new idea.

Unlike ID, the density of the keywords was calculated by the total number of keywords divided by the total number of sentences. This was done to control for the fact that ideas that are introduced with keywords occur during the course of the sentence so it would not be meaningful to divide by the number of total words as in ID values. Upon comparing the data from the keywords algorithm and the CPIDR ID values, the results revealed that there was a large and significant correlation between keywords and ID.

[Runco et al. \(2017\)](#) study also showed that the higher frequency of ID was related to both reputational change obtained from encyclopedic entries and in terms of [Ludwig’s \(1992\)](#) Creative Achievement Scale (CAS) designed to measure the creative accomplishments of deceased individuals based on information extracted from biographical sources. This study investigated these eminent people writings and calculated their ID values by using the CPIDR. The results indicated that CAS and ID have a statistically significant relationship. In other words’ ID can be a predictor of creative achievements. [Turkman et al. \(2019\)](#) study also took the ID method into consideration to test the keywords method’s functionality, which is based on general tendencies of introducing original ideas in sentences. The ID method also here showed a significant relationship with [Turkman and Runco \(2019\)](#) keywords method.

Four Applications of Idea Density in Creativity Research

Ideas play a critical role in creative thinking and innovation. Hence, many creative potential tests focus on ideas. These four creativity research studies were conducted between 2015 and 2017 and they each employed ID in the study of creativity ([Runco et al., 2017](#)). The overarching goal of all four studies was to see how ID could be applied to traditional creativity research methods in order to evaluate ID’s practical and methodological usefulness to the creativity research field. Each of the four studies applied ID differently to assess creative potential or achievement as identified with conventional creativity research methods.

The first study examined the relationship between ID and citation impact (CI). CI often is used to measure the quality of research articles and thus the eminence of the researcher. It is reasonable to postulate that works that are dense in ideas (high ID) would be cited more often compared to works that are less dense in ideas (low ID). The findings supported that ID was positively correlated with CI, confirming that articles that are denser in ideas are more frequently cited.

The second study investigated the connection between ID and eminent people. It is reasonable to consider that eminent people present works that have high ID values. In this study the writings of eminent authors was compared to the ID of their published works. Level of eminence was calculated in previous archival research on reputation and creative achievement. The findings supported that ID was positively correlated with the creative achievement rankings. ID was also positively correlated with positive reputational changes, meaning that those writers who had higher ID values also gained greater fame as their careers progressed.

The third study analyzed the relationship between ID and Divergent Thinking (DT). DT tests are typically scored according to four criteria: fluency—the number of ideas, originality—number of new and unusual ideas, flexibility—number of connections among different areas and ideas, and elaboration—details about the ideas. Previous creativity research has demonstrated a positive correlation between fluency and originality (Hocevar, 1981) meaning that originality comes with more ideas. The findings confirmed that ID was positively correlated to both the DT test and to the Runco Ideational Behavior Scale. This supports the claim that people who demonstrate high levels of ID are divergent in their thinking and more frequently engage in creative behaviors.

The fourth study examined the ID of TED Talks correlated with the “hits” the talk logged online. In this study it was shown that people like to watch or listen to TED talks that contain more ideas demonstrating that ID is indeed an important factor to evaluate the quality of written or oral works as determined by public interest.

Together these studies showed that written and oral works with higher ID values made larger impacts on others and gained more attention. This concurs with what is known about how people value ideas. People check their phones increasingly often during the day. Each time they check their phone they get new information from messages, apps, notifications, etc. This interaction gives them new information consistently. It is like a reward for seeing something new all the time and this motivates them to use their phone more and more because this is part of their nature. Individuals tend to repeat actions that are positively reinforced. So if ID measures the density of ideas, and those “denser” works reach more people, then it is in the best interest of authors to create work that considers this desire for new information in a concise format. Readers and listeners want authors and speakers to get to the point and present them with new and exiting information during the interaction.

General Discussion

The Four Application Studies confirmed a priori expectations: high ID values correlated to high assessment of creative performance and influence. Each of the four studies contributed a dimension of how ID can be used alongside creativity assessment methods for more nuanced perspective of how creative ideas are made and how they influence others. Since ID is a measure of density and therefore efficiency, the “richness” of a work is important for evaluating and assessing the performance of creativity.

In creativity literature there continues to be a primary concern about fluency’s possible contaminating effects where fluency counts the total number of all ideas that a person produces during an assessment. In many studies of creativity it was seen that originality follows fluency. The more ideas generated, the more likely it is to have a higher number of original ideas leading researchers to term this “fluency’s contaminating effect.” In other words, fluency is an active factor in DT tests’ scoring, especially in originality scores because the likelihood of having “original” ideas follows the generation of a greater number of all ideas.

The most recent definitions of creativity focus on two main qualities to describe an idea as creative: original and useful. So, if an idea is not original or useful, it cannot be creative. However, original ideas do not necessarily come to our mind immediately. Individuals need to exhaust the list of our everyday ideas to arrive something new. No one tries to start a fire with rocks and sticks until they run out matches or are without a lighter. If DT tests show that people who have more ideas (fluency) tend to have more originality scores, then it can be said that by looking at these four studies that generating all kinds of ideas are prerequisites for generating original ideas. Instead of looking at the mirror from the reverse and saying that fluency contaminates originality, it should be said that fluency contributes to originality.

These studies made clear that there are significant correlations between ID and creativity. As ideas are critical to any type of creativity, this work should continue to develop new ways to use ID with creativity assessment in the future.

Further Directions

It must be noted that the technological advancement for conducting these studies was vital to their success. ID calculations would be extremely resource intensive if it were not for modern computers and programming. It is envisioned that as the technology improves, it will be possible to calculate even more text at even faster rates. It also is possible for new algorithms to be developed that are more sensitive to language patterns and specifically to the differences in written and spoken language. Currently, CPIDR and the keyword algorithms are only available in English, which immediately limits their usefulness. Refining and expanding the programs’ language capabilities is critically necessary to further this research. There also is an opportunity to merge these various programs to behave more like the battery of tests that are now used in creativity research. ID can and should be part of that discussion. Ideas and how creative people arrive at creative ideas will remain a primary topic of creativity research. What ID offers is another tool to try to understand that process.

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- Ted Talks (<https://www.ted.com/talks>).
- Web of Science (<https://clarivate.com/products/web-of-science/>).

Idea Evaluation

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Glossary

Flexibility The use of diverse conceptual categories. Thinking that is varied rather than rigid.

Fluency The number of ideas produced on a divergent thinking (idea generation) task.

Immediate Creative Product Ideas, insights, and other outcomes of the creative process that go no further (e.g., there is not sharing or social recognition).

Intermediate Creative Product Creative activities and accomplishments that are socially recognized and not just personal, but at the same time are not world-shaking. They do not change the way other people think in any lasting way, unlike ultimate products.

Originality The novelty or unusualness of products and ideas.

Ultimate Creative Product Outcomes of the creative process that are very widely recognized and which have broad impact, changing the way that other people (besides the creator him- or herself) thinks.

Valuation Finding value in ideas. Valuation can be contrasted with critical thinking which finds flaws.

Introduction

One major approach to the study of creativity focuses on outcomes and products. Other approaches focus on the creative personality, creative places, and creative processes, but the product approach is quite common, probably because products can be studied more objectively than those other things. After all, products tend to be manifest and are less elusive than many other aspects of creativity. There are different kinds of creative products.

The Utah conferences on creativity from the 1960s included discussion of *ultimate creative products*, *intermediate creative products*, and *immediate creative products*. Ultimate creative products are often professional and always socially recognized as creative. They may be famous and, at the highest levels, change the way others think about the world. Intermediate products may win awards but may not be world famous. Audiences will agree that intermediate products are creative, but an intermediate product may not change the way others think, at least in any global enduring manner. Immediate products may not be socially shared nor recognized. They are common in everyday creativity and may be some sort of new understanding of the world by one individual. Indeed, the theory of personal creativity defines creativity as the construction of original and effective meaning for the individual. Hence the product is a new understanding which is created by the individual. Immediate products may also take the form of simple insights, solutions, or ideas that are original and effective (and thus qualify as creative) for the individual, but only for the individual, in part because they are not always shared with others.

The most common immediate product studied is the idea. There is a large literature on ideation, no doubt because the creative process often begins with an original idea. That process may refine the idea, share it, publish it, and promote it, in which case it may be transformed into an immediate or ultimate creative product, but at first there is just the idea.

Many tests of creativity give examinees open-ended tasks and allow them to generate as many ideas as they can. The resulting ideas are then typically scored for *fluency* (the number of ideas), *originality* (the uniqueness or novelty of the ideas), and *flexibility* (the number of conceptual categories used by the individual and apparent in his or her ideas). Importantly, ideation can be objectively assessed with these tests. The tests are reliable and, when used correctly, they have more than adequate predictive and discriminant validity. Interestingly, the investigations of the predictive validity of tests of ideation often use intermediate products as criteria, the logic being that when a person has numerous ideas, some of which are original, he or she is likely to produce socially meaningful creative things as well.

Ideas seem to be useful for creative efforts and are certainly useful in research on creativity. Creative work does not, however, depend solely on the production of ideas. There are influences on the production of ideas (e.g., attitude, affect, motivation, knowledge) and, once ideas are generated they need to be evaluated. Very likely a person will generate ideas but reject many of them and

then continue to think about and perhaps refine those that pass muster. In many instances there is also an inter-personal evaluation of ideas. This Encyclopedia entry will review research on the part of the creative process where ideas are evaluated.

Empirical Research on Idea Evaluation

One very useful method of idea evaluation involves two phases. First ideas are collected; a sample of examinees receives tests of divergent thinking and produces a large number of ideas, some of which are original and some of which are common and unoriginal. The exact degree of originality is determined, for each idea, by checking statistical frequency. Hence an idea given by only one person in the sample is unique and given the highest originality score. Ideas that are given by most examinees are common and given a low originality score. Ideas in between are given intermediate originality scores.

This process can be quite precise. It can, for example, use exact probabilities (Runco et al., 1987). This means that the exact frequency of occurrence in the sample is used when calculating the originality score, and that score can be taken as a kind of probability (i.e., the likelihood that the person will produce original ideas in the future). This line of research on idea evaluation is not concerned with predictive validity, however, so the important thing is the exactness of the score. Suppose there was a sample of 100 examinees. Suppose also that 90 of them gave one particular idea in response to the divergent thinking question, "name round things." That idea might be "basketball," just to be specific. The originality score for "basketball" is therefore 0.9 (90/100). For simplicity of interpretations this score is usually inverted by subtracting from 1.00. That just allows high originality to have a high rather than a low score. In the case of 0.9 the score becomes $(1.00 - 0.9 =) 0.1$, which is a low originality score and makes sense because so many people in the sample (90% of them) thought of the same idea. One further convenience that is often used is to multiply by 100 (much like the original IQ calculations) which just creates whole numbers. Thus 0.1 becomes a score of 10. What of an idea that was only generated by one person or very few people? Suppose 5 people gave the idea "Pluto" to the "Round things" question. The originality of that idea would be $(1.00 - 0.05 =) 0.95$ and then 95, which is very high (relative to the maximum of 100). These scores can be interpreted much like a percentage since the scale is the same (zero to 100).

This particular method is used to determine the originality of ideas. These ideas will be subsequently used in phase two of the research on idea evaluation. The method being described here is not being used to determine the originality of the examinees, though that is the objective of typical divergent thinking testing. Phase two in the work on idea evaluation starts by selecting a group of ideas from phase one. They may be randomly selected, though that is not necessary. Indeed it is best to select ideas that represent high originality (e.g., scores of 90 and above), intermediate originality (e.g., around 50), and low originality (e.g., below 20 or even 10). Research often uses about 10 of each of those. They are placed on a new survey, at which point the arrangement should be random. Each idea is used as one item or question in this new survey. In much of the research each idea is associated with a Likert scale and instructions ask respondents to rate each idea in terms of originality. If the respondent is good at idea evaluation highly original ideas should receive the highest rating on the Likert scale, moderately original ideas should receive a middling Likert rating, and the least original ideas should receive the lowest Likert rating.

There are alternatives. Respondents taking the new survey can be asked to simply identify which are the most original ideas (without a Likert scale) and an accuracy score then based on the number of highly original ideas (determined by phase one) each examinee correctly identifies. Another method has been used with school-aged children. It uses a Likert scale but instead of numbers and words happy faces response options are used; a very happy face takes the place of the highest Likert response option and a frowning face takes the place of the lowest Likert rating. Varying degrees of smiles or frowns replace all response options. Quite a bit of work has demonstrated how well this happy face method works with school children.

School children have also been asked "how many of your friends are likely to give this idea?" instead of "rate the ideas for originality." That is because children may have an easier time judging the former (how many friends) than the slightly more abstract "how original?"

Another variation involves the rating criterion. In the example above originality was targeted but research has also asked about the quality of the idea (i.e., its effectiveness or usefulness) and the popularity of the idea (in case it is easier to judge the opposite of originality than the infrequency of ideas).

It is fairly easy to summarize the key results of this line of research:

In the first investigation using the two-phase methodology just described, Runco and Vega (1990) collected data from both parents and teachers who were asked to evaluate the ideas given (in phase 1) by children. Runco and Vega were especially concerned about data on the fourth grade slump, which at the time of this research was reported to manifest itself in about 50% of the fourth grade children in USA. The parents and teachers also received their own divergent thinking tests. That was because one hypothesis was that idea generation is related to idea evaluation. Analyses indicated the following:

1. Parents with more children were more accurate than other parents when evaluating children's ideas.
2. Ratings of the popularity of the ideas were significantly different from ratings of the originality of the ideas, which supported the idea that parents and teachers do, at least implicitly, recognize that original ideas are uncommon and in a sense unpopular.
3. The accuracy of the ratings given by parents was not significantly different from the accuracy of the teachers. Both were accurate at approximately the same level and neither group differed much from adults who were neither parents nor teachers.
4. Divergent thinking scores were correlated with evaluative accuracy. This was interpreted as an indication that people who give numerous ideas have more practice evaluating ideas than others and as a result are better at judging ideas.

Not long after that report was published [Runco \(1991\)](#) used the same two-phase methodology with children (rather than adults). One interesting question involved a theory in the creativity research at that time, namely that children were not actually creative at all. In this theory children are accidentally original in their thinking and ideas, and they think and share things that seem to be original to adults but only because the children do not know any better. Adults attribute creativity to these children, in this theory, because they are surprised by the ideas, but the ideas are not actually original, just uninformed. Note the assumption here that creativity is intentional. That is debated in various lines of creativity research, including that which discusses how to best define creativity and that which discusses moral creativity (see [Runco, 1993](#)). The research conducted in 1991 also gave children (in phase 2) divergent thinking tests so the relationship of idea generation with idea evaluation could again be examined. Analyses indicated the following:

1. The idea evaluation measures were highly reliable. That was an important result because it was possible that children would have difficulty with the idea evaluation surveys or that their idea evaluation skills were not yet mature.
2. Divergent thinking (idea generation) was again significantly correlated with idea evaluation accuracy, but the correlation was only moderate. To be precise just under 40% of the variance in the divergent thinking and idea evaluation scores was shared.
3. Idea evaluation accuracy was unrelated to intelligence test scores (i.e., the WISC-R IQ test), which supported the discriminant validity of this kind of evaluation and suggests that children who have high IQs might not be good at evaluating ideas. This is consistent with research on divergent thinking, which is also typically unrelated to IQ.
4. There were instructional effects in that children were the most accurate at evaluating ideas when they were told to estimate the number of other children who would think of each. In short, judging popularity was easier than judging creativity. It is not much of a surprise that it is difficult for children to judge creativity per se, given that it is an abstract concept. Yet given that popularity can be judged accurately, and given that popularity is antithetical to the originality that is required for creativity, it may be that there is a method implied here that would help children judge creativity or increase the originality of their ideas and solutions.
5. Idea evaluation accuracy was unrelated to the age of the children. This could reflect the restricted range of ages. Also, there were no differences between girls and boys in terms of evaluative accuracy.

It is likely that somewhat different processes and criteria are used when judging one's own ideas vs judging ideas given by someone else. For this reason [Runco and Smith \(1992\)](#) compared inter- and intra-personal idea evaluations using the same two-phase methodology. They also administered a "preference for ideation" measure to determine if attitudes were involved in idea evaluation. The key findings were:

1. Canonical analyses were used and confirmed that there was a statistically significant correlation between inter- and intrapersonal evaluative scores. They shared about 40% of their variance.
2. Interestingly, there was also a significant correlation between divergent thinking and intrapersonal evaluative accuracy.
3. There was another significant correlation between the preference for ideation attitude and interpersonal evaluative accuracy.
4. Participants were significantly more accurate when they were asked to evaluate the uniqueness rather than the popularity of their own ideas, but significantly more accurate when evaluating the popularity rather than the uniqueness of ideas given by others.
5. None of the evaluative accuracy scores were very impressive. The highest percentage of correct identifications was for interpersonal evaluations, where 42% of the popular ideas were correctly identified. The lowest category was intrapersonal evaluations, where only 21% of the popular ideas were correctly identified. These results are quite important and suggest that people may not be very good at judging the originality of ideas. That could easily get in the way of efficient creative problem solving and, in this light, may point to a target for creativity enhancement efforts.
6. Both intra- and inter-personal evaluative scores had discriminant validity. Both were unrelated to standard measures of critical thinking. This extended the finding above where evaluative accuracy was unrelated to IQ scores.

Min Basadur presented a very useful model of creative problem solving that includes evaluative accuracy, as well as idea generation and attitude. This model was developed for use in organizations. With that in mind the next research project examined the evaluative accuracy of managers. [Basadur, Runco, and Vega \(2000\)](#) were also interested in improving creative problem solving so administered a program to improve ideation. Four styles of creative problem solving were assessed, namely labeled generator, conceptualizer, optimizer, and implementor. Analyses indicated that the training improved the evaluative accuracy of the managers. The impact of training was moderated by the conceptualizer style of thinking and by the "preference for active divergence" attitude. The relevance of these two things implies that accurate idea evaluation might be predicted from certain characteristics, at least among managers.

[Rietzschel et al. \(2014\)](#) also took a practical approach to idea evaluation. Their interest was in brainstorming groups. As they described it the typical brainstorming group leads to an increase in idea quantity but not quality. That is probably because brainstorming has three guidelines, and one of them is "quantity over quality," the message being that the group should not worry about quality, nor evaluating ideas as they are produced, but instead should focus on making sure that the largest possible pool of ideas is generated. This makes the most sense when a second guideline is acknowledged, namely "postpone evaluation." Note that the guideline is not "eliminate evaluation." Creative ideas must be effective as well as original so at some point an evaluation is vital; but evaluation can be postponed until late in the process, after a large pool of ideas is available. The third guideline is "hitchhiking," which is a simple method whereby each individual attempts to extend the thinking of other individuals. Rietzschel et al. collected data from various brainstorming groups and manipulated *problem scope* (broad vs narrow) and group instructions (emphasizing

personal relevance vs idea creativity). Analyses of the output indicated that the instructional type and the problem scope were related to the evaluative accuracy within the groups. In particular the groups preferred more creative ideas when they had received creativity instructions and when the focus was on a narrow problem scope.

de Buissonjé et al. (2017) also started with the notion that evaluative accuracy could be improved. Their method differed from the one used in the series of studies described above, where there were two phases. de Buissonje et al. presented research participants with 18 ideas and asked that the five most creative ones be selected. The procedure to improve selection involved inducing positive affect as well as a promotion focus (via a self-affirmation task) before the ideational measures were presented. Both of these pre-evaluation manipulations were indeed likely to influence selection accuracy. Positive affect, for example, is frequently associated with creative performances, the idea being that individuals who are in a good mood are more open minded and consider a wider range of solutions than otherwise. Analyses confirmed that positive affect and the promotion focus did lead to increased accuracy.

Discussion

The research on idea evaluation is in its infancy compared to the research on the generation of ideas. Still, some headway has been made, as is evidenced by the research summarized in this chapter. This research indicates that there are differences between inter- and intra-personal evaluations and that there are various influences on the evaluation process. Attitudes, creative styles, affective states, problem scope, and promotion focus were all examined in the research and found to relate to evaluative accuracy. The research is, in this sense, consistent with the idea of a creativity complex. Creativity is not a unitary thing but instead involves different processes and is influenced by a variety of factors, some cognitive, some extracognitive.

The differences between inter- and intra-personal evaluations are especially intriguing. They might be explained in terms of the available information or in terms of divergent perspectives. Someone judging his or her own ideas will, for example, have information about context and associative history. They will know where any one idea came from, what it was associated with, and what else was in the same associative chain. This may lead to low originality evaluations because if a person produces a chain of associations and the ideas are each related to one another, any one idea may appear to be much like the others and thus not all that original. Other people would not have that same information and thus might see the same idea as highly original. They would not be aware of all of the similar ideas that might have been considered by the person producing the ideas and in the same associative chain. Interpersonal judgments differ from intrapersonal evaluations, in part because the former have no information about associative histories.

One implication of the research on idea evaluation can be directed to other research on creativity which involves judgments and raters. There is quite a bit of research that uses judgment and raters, including that relying on the *consensual assessment technique*. That method was developed to study the impact of various social conditions on creative outcomes. It was initially used to produce ratings of products such as collages and poems, but it has been used to collect data on a wide range of other products as well. It does depend on judges, and the research on idea evaluation suggests that there may be differences among groups such that one group will offer ratings that may very well differ from ratings given by another group. The problem is, then, that the validity of ratings may not generalize, so the results of any one study, using any one group, may not apply to other groups.

Certainly more research is needed on the topic of idea evaluation. The research summarized in this chapter used several different methodologies, which means that results are difficult to compile, and there is not enough data available for a meta-analysis. The only marginal correlation between idea evaluation and idea generation indicates that these represent two fairly distinct skills, and models of the creative process recognize both—along with some sort of problem finding or problem identification skill. This too implies that more research is needed specifically on idea evaluation. It is an important part of the creative process, and probably the part where the least amount of empirical information is available.

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Imagery

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Imagery

Mental imagery is a form of internal representation that occurs spontaneously or deliberately in the human mind. It can refer to any sensory modality (visual, auditory, olfactory, gustatory, tactile, motor or kinaesthetic), involved in seeing in the mind's eye, hearing in the ear's mind, smelling in the nose's mind, and so forth. This means that imagery resembles perceptual experiences representing information stored in long-term memory, as well as events of various type (e.g., past experiences, future scenarios), spatial relationships between the parts of objects or locations of the sensory stimuli, and movements. Imagery is also a means of symbolization, because it stands for information originally perceived by our senses, which is replaced by conventional signs, and for information that emerges by merging different sensory elements of ideas, for example when the mind is engaged in creative thinking. In other words, imagery is a representational medium of both modal (sensorimotor) and amodal (spatial and symbols) information. It facilitates thought processes, supporting different cognitive operations, including imagination and fantasy, that rely on a broader concept than simply the imaging of a stimulus, event or symbol. Indeed, imagination or fantasy involve elaborated cognitive activity that is based on sequences of stimuli and events that recombine the content of the thought in new images and ideas.

Across years the idea that imagery is also an essential component of creativity has increasingly attracted the attention of the scientific community. It is assumed that creativity can benefit imagery because it is flexible and allows combining multiple elements into new ideas, as well as to favor pattern discovery, mapping relationships or regularities between things into general mental representations or mental models.

The association between imagery and creativity has been hypothesized primarily on the basis of the numerous anecdotal accounts that have been reported by artists and scientists. One of the most famous example is Kekule's dream about a snake seizing its own tail, leading to the discovery of the Benzene structure. Others accounts highlighted the importance of voluntary manipulation of images during the creative process. Nikola Tesla used mental images of mechanical models that ran for several weeks to understand which parts of his inventions (e.g., self-running engines) could be subject to premature wear. According to these reports, discovery and creativity would arise more or less directly from visual images. However, non-visual imagery modalities have also been suggested as being involved in creative processes. Mozart and Wagner essentially claimed that they were supported by auditory imagery during their compositions. These and other anecdotal accounts reveal that imagery is a language of discovery, that can occur in parallel with spontaneous or unconscious thinking or with deliberate thinking.

However, at the empirical level, the association of imagery with creativity is not always clear and expected, because it varies as a function of individual differences in imagery abilities, cognitive style, domain of knowledge (e.g., visual, musical, olfactory, motor contexts) and content. Creative people share various characteristics across domains, such as imagery, and in particular good imagination, the tendency to think metaphorically, the use of wide categories and images, the preference for non-verbal communications, and the ability to create internal visualizations.

Different approaches can account for the extent to which way creativity benefits from imagery. The first approach relies on the view that imagery is a subjective or phenomenological experience, that cannot be objectively observed. It is only possible to infer other people's imagery by their verbal accounts or behaviours. This approach traditionally focused on the relationships between the self-report vividness of imagery and traditional psychometric measures of creativity, as systematized by divergent thinking. However, it also possible to find studies that correlate vividness of imagery to actual creative behavior and sparsely to attributes of creative products.

The second approach underpins imagery as an independent internal representation and assumes relevance on the basis of its capacity to predict objective performance. On the one hand, it correlates spatial tests to creativity, on the basis of the evidence that spatial tests can also involve the use of imagery. On the other hand, it focuses on the emergent properties of imagery, on

the basis of the experimental evidence that imagery is characterized by properties (perceptual, spatial, and transformational) that support the creative process.

The third approach has been developed within the frame of embodied cognition and conceives imagery as a non-automatic mental simulation that relies on the partial reactivation of past sensorimotor experience (simulation view), or as an ongoing activity that allows the body to interact with its environment (enactive view). The simulation view focuses on imagery as an internal mental representation, whereas the enactive views it as a motor process.

Imagery as a Phenomenological Experience and Creativity

Imagery conceived as a subjective experience is related to vividness and control of mental images. Vividness refers to the ability to form clear and detailed images, associated with the preservation of perceptual information whereas control is the ability to retain images for sufficient time to effect the desired rehearsal, being associated to the voluntary manipulation of images, regardless of their vividness.

Both vividness and control have been hypothesized to be associated with divergent thinking, that is to the ability to produce an open-ended ideational searching of ideas for problems that have no right or wrong answers (e.g., alternative uses task). Divergent thinking represents an indicator of the creative potential rather than of creativity and can be expressed in different forms, such as verbal, visual (see the Torrance Test of Creative Thinking (TTCT), and motor domains (e.g., [Palmiero et al., 2019](#)). Although divergent thinking tasks rely on the use of imagery, for example different scenarios are imagined while finding alternative uses for a common object, or various images are generated while making different drawings starting from given shapes or parallel lines, the extent to which vividness and control of imagery contribute to divergence is unclear. Vividness and control explain only a small part of the total variance of divergent thinking scores (fluency, flexibility and originality), regardless of the form (visual or verbal) of divergent thinking.

The relationship between vividness of imagery and creative behavior is more consistent. People with higher visual art involvement generally show higher vividness scores of visual imagery as compared to individuals with lower visual art involvement or non-artists. This notion is also in line with the evidence that visual artists rely on the object imagery cognitive style, which is supported by pictorial representations of visual stimuli, defined in terms of specific attributes, such as shape, size, color and brightness. Vividness of visual mental imagery has been also associated to functionality of creative objects produced mentally combining visual elements and in domains of knowledge including creative writing and music.

Imagery as an Independent Internal Representation

Imagery is also conceived as a medium by which information about the appearance of perceptual stimuli, events and symbols can be represented and manipulated objectively. This leads to the assumption that imagery is independent from other forms of mental representations (e.g., verbal).

However, the issue of the independence (nature) of mental imagery has been debated. According to the depictive approach ([Kosslyn et al., 2006](#)) visual imagery would function as a modal analogue of visual perception, involving internal picture-like representations. In support of this view, visual images have been found to possess inherent properties of real stimuli, such as spatial extension ([Kosslyn et al., 2006](#)), and to be topographically organized at neural level, allowing the generation of patterns of activation in top-down fashion as compared to visual perception ([Kosslyn and Thompson, 2003](#)). In this vein, visual images can be rotated, scaled, scanned, and inspected as if one is engaged with real objects. Across years, the analogue approach has been extended to other imagery modalities. The neuroimaging techniques confirmed that specific imagery modalities rely on specific neural networks (e.g., neural circuits corresponding to primary or secondary sensory areas and adjacent brain areas).

Nevertheless, the view that imagery has no symbolic independence has also been proposed ([Pylyshyn, 2002](#)). According to this view, imagery is rather an epiphenomena that sub-serves other cognitive processes. Images are descriptive, amodal representations that rely on abstract, propositional-like format. In addition, images are cognitively penetrable by the tacit knowledge of the world. For example, given that individuals know that more time is needed to cover longer distances, they would take more time to mentally scan longer than shorter distances.

With this in mind, the understanding of creativity appears to be more consistent with the idea that imagery has symbolic independence and possesses properties that can lead to new discoveries. Imagery preserves to some extent sensory-motor properties, even though there are also propositional or amodal components that can take part to the creative process. Therefore imagery specifically contributes to creativity in both subjective and objective measures.

Spatial Tests and Creativity

Imagery modelled as an independent internal representation can be associated to creativity as a form of spatial ability, which is a multicomponential dimension that also includes imagery, that is the visual memory factor, that partially overlaps with the general visualization factor ([Carroll, 1993](#)). The visual memory factor involves imagery because it requires individuals to visualize, maintain and manipulate two- or three-dimensional information in the mind's eye as accurately and quickly as possible.

These spatial imagery operations allow the individual to see the same problem from different perspectives, and, therefore, increase possibilities for multiple creative solutions. Nevertheless, the evidence about the relationships between spatial imagery ability and creativity is contradictory.

Emergent Property of Imagery and Creativity

Imagery relies on an independent internal representation that encompasses properties that cannot be readily deduced but can emerge after opportune cognitive operations (e.g. superimposing letters), giving rise to creativity. However, the discovery of emergent properties is obviously not unlimited, given that the individual differences in imagery abilities, complexity of the stimuli, loss of information in the mental images and structural thinking (imagination) not always allow to go beyond the existing knowledge.

Focusing more directly on the creative potential that the emergent properties of imagery can imply, it is necessary to refer to the creative cognition approach, formalized by the Geneplore Model (Finke et al., 1992). This model assumes that creativity emerges through the mental visualization of specific forms, as an ongoing cycle of generative processes (e.g., association, mental synthesis), and exploratory processes (e.g., conceptual interpretation, functional inference). The generative processes are used in the construction of pre-inventive structures, whereas the exploratory processes are used to examine and interpret the pre-inventive structures. The generative and exploratory processes are recursive until a satisfactory invention has been created.

This approach has been operationalized by three tasks. The creative mental synthesis task (Finke et al., 1992), first requires the use of the mind's eye to rotate, change in size and embed the basic elements to construct a pre-inventive form. In the second step individuals have to think of possible applications (uses) of the pre-inventive structure in order to reinterpret it according to the specified conceptual category. During reinterpretation, mental rotation of the whole pre-inventive structure is also possible. The ability to represent pictorial information (vividness) has been found related to functionality of inventions: positively when the task was carried out in one single step, that is, when the object was created with a conceptual category in mind, and negatively when the task was performed in two steps, that is, when the pre-inventive form was created and then interpreted within a specific conceptual category. In addition, transformation imagery abilities and visualization cognitive style have also been associated to originality of objects. This task places more restrictions on the creative process, requiring more goal-directed thinking, and is more associable to scientific creativity. Secondly, the conceptual expansion task (Ward, 1994) allows the shift from existing schemas (e.g., earth animals) to new schemas (e.g., extraterrestrials) in order to expand the basic concept. Individuals are required to use the mind's eye to visualize the original schema of the animal, and to imagine the extraterrestrial living on a planet different from the Earth. Retrieving and representing knowledge at multiple levels of abstraction are associated with higher original extraterrestrials (Ward, 1994). This can be seen as evidence that the use of analogue images formed by information stored in memory prevents conceptual expansion. This task lays less restrictions on the creative process and seems more associable to artistic creativity. Third, the constraining effects of examples with the toy task (Smith et al., 1993) measures the ability to create a toy which does not conform to exemplars that participants are exposed to. This task also requires imagery because participants have to think of the structure of the new toy and visualize possible applications of it. Therefore, imagery plays a key role not only during the generative phase of the pre-inventive structure underlying the creative object, extraterrestrial or toy, but also during the exploratory phase because it serves to contextualize and verify the appropriateness of the idea.

The framework of the creative cognition approach offers a unique opportunity to understand the role of imagery in the creative process. During the creative mental synthesis task combining occurs in imagery, whereas restructuring requires sketching, giving the possibility to inspect and find new interpretations of the initial images. This means that to pursue creativity, for example in design, imagery might be not sufficient; it is necessary to lean on externalizations (sketches) of ideas to overcome design fixation (for a review see Alipour et al., 2018), that is the restriction of the possibility to achieve a creative solution. This is generally true for innovation and art, since inventions (e.g., Kekulé's discovery) and artworks are developed by getting free from the original imagery-based conception, and relying on restructuring processes. In more practical terms, it is possible to assume to some extent that whereas combining of elements and ideas can occur in the generative phase, involving a strong component of imagery, restructuring takes place mostly in the explorative phase, that might be supported also by external aids. This cycle of interacting generative (combining) and exploratory (restructuring) phases continues until a creative idea is revealed, discovered.

Imagery and Embodied Cognition

The embodied cognition approach disregards the notion that cognition relies on abstract symbols, and focuses on the idea that perception is direct and serves to guide actions while the body interacts with its environment (Varela et al., 1991). The sensorimotor capacity of the body offers possibilities (affordances) of interactions with the environment. This means that cognition is grounded in the body and perception and action are inseparable. Basing on these assumptions, the conservative embodied approaches retains the concept of representation (e.g., the simulation view), whereas the fully embodied approaches totally reject it (e.g., the enactive view) (for a review see Palmiero et al., 2019b). Thus, imagery can be conceived as an embodied mental simulation-based representation, or as an embodied action-based process, with implications for creativity.

Imagery as a Mental Simulation and Creativity

Imagery as a mental simulation relies on sensorimotor processes through the reactivation of the same neural regions that are recruited in actual perception (Barsalou, 1999). According to perceptual symbol systems (Barsalou, 1999), selective attention allows to extract schematic representations of perceptual experience, which are subsequently stored in memory to function as modal symbols. Experience allows to integrate different perceptual symbols into a simulator that produces limitless simulations of the percept and implements all cognitive operations. The most of simulations arise spontaneously whereas imagery is a non-automatic simulation of perceptual symbols. Given that different simulations can be produced by the same simulator, experience can be surpassed in many ways.

This means that productivity of automatic and not-automatic (imagery) simulations constitutes an important source of creativity, such as the creative scientific thinking (e.g., the power of analogies). With respect to the depictive approach, that is also based on the notion of mental representation, this view accounts for creativity not in terms of emergent properties but rather as a mental process that is used to simulate results, solutions and alternatives of the creative process.

Imagery as an Ongoing Activity and Creativity

Following the enactive view, perception uses sensory systems in order to actively seek for specific information needed at a specific moment, as a sort of ongoing exploration of the environment. By consequence, an inner generation of a system of meanings by actions and interactions between the organism and the environment would be created. In this vein, imagery is also based on active exploration of the environment almost as during perception. The visuo-spatial recollections of stimuli from long-term memory are not internal spatial representation, but rather are visuospatial behaviours that are guided by overt attention shifts (e.g., eye movements). The peculiarities of the body and the types of interactions with the environment can give rise to different images in terms of phenomenological and functional properties.

The view that imagery relies on active exploration as a sort of allocation of attentional resources is supported by interference and facilitation effects of imagery on perceptual tasks. In practice, attention devoted to the visual images impairs visual perception in mismatch condition (images and percepts do not correspond), whereas they facilitate visual perception in match condition (images and percept do correspond). Studies of motor behavior occurring during imagery also support the enactive approach, such as eye movements in visual imagery, considered as motor processes that occur during active exploration of the environment, or the typical act of sniffing in olfactory imagery, considered as a motor activity that helps to generate images of odours. Yet, motor cortices (e.g., premotor area and/or supplementary cortex) have been found recruited in all mental imagery modalities (Winlove et al., 2018).

The evidence that imagery conceived in enactive terms supports creativity comes from neuroimaging studies that revealed the recruitment of motor cortices during the execution of creative tasks strongly relying on mental imagery (for a meta-analysis see Boccia et al., 2015). For example, the creative mental synthesis task has been found to recruit, amongst other areas, the premotor cortex. More specifically, while designing book cover illustrations the premotor cortex has been found activated during the generation phase and the supplementary motor area during the evaluation phase of ideas. Given that the premotor area is related to object rotations while the supplementary motor area to rotations of the self about an object, it seems that during the visual creative process, the generation of objects is supported by mental rotation processes, whereas the evaluations of the objects implies that the subject imagines him/herself while using the objects for a specific purpose.

Conclusions

Mental imagery is assumed to play a key role in creativity. Different studies addressed the issue of the relationships between imagery and creativity using a variety of approaches, ranging from psychometric methods based on individual differences (vividness and spatial imagery) to cognitive approaches (internal representation). With the advent of the embodied cognition approach the relationships between imagery and creativity has also been conceived in terms of mental simulations and sensorimotor capacities of the body interacting with the environment. In general, although it is not possible to deny that during the creative production of ideas individuals are supported by imagery, the extent to which imagery contributes to creativity has to be still fully disentangled. Vividness and spatial imagery appears to be scarcely correlated to creative performance, whereas the conception of imagery as an independent internal representation that allows the emergence of creativity has produced more convincing results. Interestingly, imagery conceived as a mental simulation that can help to predict results of the creative process also support the creative process. Considering the anecdotal accounts, whereas the Kekule's discovery can be explained as a form of internal mental representation (unconscious) that has allowed to 'see' the structure of the Benzene, Tesla's invention can be explained in terms of mental simulations, that were run to predict results. Finally, imagery as a motor process also seems to explain to some extent the creative process. The general picture is that imagery is a multi-componential construct that supports creativity in multiple fashions according to the task used to express creativity, the domain of knowledge and the individual differences in imagery skills and creativity. Most importantly, in order to move on the understanding of the relationships between imagery and creativity it appears that a wider perspective is necessary: imagery is not only a representational medium that conveys creativity, but is also a mental process that influences creativity. Basing on the idea that mechanisms

underlying vision for action and unconscious visual imagery do overlap (Brogaard and Gatzia, 2017), the view that imagery is a process action-based would also help to better address the unconscious aspects of imagery involved in creativity.

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Imagination

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What Is Imagination?

Imagination is a human cognitive capacity involved in the reproduction of images, experiences and thoughts. However, imagination not merely reproduces, but in the imaginative process, the representations of former experiences, thoughts and images are combined into new constructions. Imagination thus involves the transcendence of reality. Imagination might be anticipatory to deal with the future (*What will happen if I solve this task in this way?*), reproductive to process the past (*what would have happened if, I had acted differently?*), or creative to form new original constructions (*what will happen if I combine my knowledge and experiences in new ways?*).

Imagination is a unique human capacity that psychologists often have an ambivalent attitude towards. It is hard to study imagination experimentally at the same time as it is a fascinating capacity that cannot be ignored in social sciences. It plays a role in many complex human functions, such as planning, problem-solving and creativity and often in interaction with rational thinking (not necessarily in contrast with).

Early 20-century theorists, suggested different distinctions between imaginative and realistic thinking. While the psychologist Eugen Bleuler, in 1912, argued that imagination was a relatively sophisticated ability, other scholars, such as Sigmund Freud and Jean Piaget saw it as a primitive process that would dominate the child early on and that would later be subordinated by realistic and logical thought. The term used by Freud, *primary process* in "Formulations regarding two principles of mental functioning" reminds of Piaget's *egocentric thinking*. They both describe the imaginative form of thinking as having a playful, magical, lucid character and being run by the *pleasure principle*, which means that pleasures and wishes are in focus and that this mode of thinking does not adapt itself to reality. Psychoanalytic thinkers asserted that primary process continues throughout the life-span but is accompanied with more realistic thinking from the age of three to four. Realistic thinking will become increasingly important and help children adapt to the *reality principle*, which means that they can find ways of fulfilling their wishes that is acceptable for others, for instance waiting for their turn. Piaget argued, in "Play, Dreams and Imitations in Childhood", that imaginative thinking and pretend play will be more or less substituted by logical thinking and rule play at about the age of seven.

Bleuler's idea has been supported. Bleuler (1912/1951) proposed that the conceiving of alternatives to reality is a sophisticated capacity that is not possible until a more reality-directed thinking has been established, contrary to Freud and Piaget who hypothesized that children started out with imaginative thinking. Moreover, several imagination scholars today, for instance Inge Bretherton and Paul Harris, assert that the imagination must have a function in human life and cannot only be a mal-functional process that should disappear when the child matures. Research studies have provided support that imaginative play fulfils advanced functions that will help children delineating reality as well as practicing different types of human functioning. Marjorie Taylor and Stephanie Carlson (1997) demonstrated that, in for instance play with imaginary companions, children's social ability and understanding of thinking processes are furthered and is likely to lead to better social functioning in the real world (see Play).

In the 1980s, Jerome Bruner developed his theory on the two forms of thought that humans have evolved. The so called *narrative thought* would be closer to imaginative thinking. Bruner (1986) described narrative thought as bursts of images communicated as sequential statements and this form of thinking emerges in fantasies, dreams and memories and in "what if" speculations. The other type is rational thinking (termed *paradigmatic* by Bruner) and is more orderly and logically structured. The two types of thinking

Bruner considered just as important and have different functions, of which narrative thinking strives for lifelikeness and paradigmatic thinking aims towards the truth. Both these modes of thinking are decisive to organize and understand human experiences. In Donald Winnicott's tripartite model (1995), he added a third kind of thinking sphere that combines materials from reality and imagination. This *transitional sphere* depends on children's advancement in handling representation. As a result of this development, children can merge real objects and symbolic content, something which makes it possible for them to invent transitional objects, such as comfort blankets and teddies. Instead of using the parent as the secure base in frightening or insecure situations, children can make use of transitional objects, which may function as comfort by representing parental safety. It means that a real object with the help of imaginative transformation can become something else – an illusion or symbol for security.

Imagination, Reality, and the Illusionistic Sphere

The transitional sphere between reality and imagination was further outlined by Paul Pruyser (1983), who called it the *illusionistic world*. However, it is not merely in childhood that illusions are made use of, for example in pretend play. The illusionistic sphere continues to be important throughout the lifespan. All forms of play belong to the illusionistic world through the players' creation of something in between the real world and the imaginary world. Pruyser maintained that adults also play through the appreciation of fine arts and in various other creative expressions.

Research has found that healthy adults maintain positive illusions in order to function well. Even if self-deception might seem contra-productive at first sight (and certainly excessive self-deception will be), adaptive positive illusions may give people an impetus for growth. Many challenging tasks would never have been completed, had the uphill battle ahead been fully understood. Illusions such as, unrealistic optimism, exaggerated sense of control and individuals' distorted sense of their capacity have made many incredible endeavors come true.

Play and creativity can also have therapeutic qualities both for children and adults, among other things because the illusionistic sphere is a resting place between one's internal and external world. In the lifelong struggle to keep imagination and reality separate, individuals can pause in the illusionistic sphere and play with alternatives to reality or "play with representations", as Inge Bretherton and Marjorie Beeghly (1989) put it in their profound analysis of children's pretend play. This third sphere consists of a kind of imaginative thinking that Pruyser described as tutored imagination, something which arises when imaginative thinking is combined with realistic thinking in a more deliberate process. The imagination world, would then be something more untamed and more spontaneous. In this chapter, however, both the untutored and tutored imaginative thinking will be referred to as imagination. There are many other constructs that are closely related to the concept imagination, of which *fantasy*, *day-dreaming* and *counterfactual thinking* and some others will be discussed briefly.

Constructs Related to Imagination

Fantasy is a product of the imagination, but often refers to imaginary content farther removed from reality, meaning that it is less likely to occur in individuals' real lives. Fantasy can either be pleasant and wishful in content or involve scaring and catastrophic scenarios.

Other sibling concepts to imagination are used in different research fields. Neuropsychological studies of the so called *default-mode activity* is of interest for the knowledge of imagination, even if this activity involves more than merely imaginary processes. The default-mode activity, as discussed by Jessica Andrews-Hanna et al. (2013) and Jonathan Smallwood (2013), refers to the brain activity in individuals at rest and not involved in anything particular. However, when doing nothing, or in default-mode, individuals often overcome the constraints of the present situation by mentally representing some other place, time, or stand-point, something which is a core aspect of imaginative cognition. These internal mentations may include recollections of past experiences and the construction of future scenarios. The terms *task unrelated thought*, *self-generated thought* and *mind wandering* have also been used in neuropsychology to describe default-mode activity. Within other fields, the terms *stream-of consciousness* (in literary analyses of interior monologues) and *daydreaming* also refer to similar processes. In this chapter, all these constructs representing inner states, in which individuals' attention is directed towards their private thoughts and feelings, will be referred to as daydreaming.

Counterfactual thinking is mental representations of alternatives to past actions and events. It is a more deliberate kind of imaginary process than daydreaming and involves thinking about what might have been.

The emerging ability for imaginary and counterfactual thinking begins to develop surprisingly early together with the first attempts to operate in the subjunctive pretend mode ("as if"-acting) and involves the creation of possible and impossible event representations.

Imagination Throughout the Lifespan

The Development of Imagination in Children

Imagination is a human capacity, but has predominantly been associated with children and childhood activities, such as make-belief and sociodramatic play. The first signs of pretense appear as early as the beginning of the second year when children for instance pretend that they are asleep by closing their eyes. Soon, during the third year, children can enact routine family life events, such as going to bed and later they can act out situations that they have only vicariously experienced, such as going to work.

Bretherton and Beeghly described the long process of development before children have fully acquired the ability for more advanced sociodramatic role play, among other things by learning to handle roles, plots and props. Early forms of pretense often only involve a single role, simple plots and realistic props, whereas later forms of sociodramatic play will also include complex role structures, intricate plots and imaginary or less conventional props. Some other interesting features of role play is the development of meta-communication and different stage-management techniques in order to negotiate the content of play with other players. Techniques to direct pretend play are *magicking*, that involves chanting the pretend action (e. g. “stir, stir, stir” when stirring the soup), *storytelling* (“we went to sleep”), that is telling what is happening and *prompting*, referring to the whispering of stage-directions to the other players (“you were still asleep”). There are some necessary developmental steps in order to master the more advanced types of pretend play: Moving away from the present, steering thought processes and distinguishing between reality and fantasy.

Important Developmental Steps

To *move away from the immediate present* is a crucial development. When fully developed it means that individuals are able to overcome the obstacles of the present by mentally simulating another time, place, or view, which will help them, for instance, distance themselves from the real world or create novel things. The first experiences of moving away from the present is simple active recall of something not present. This process involves the ability for representation but the full development will also involve metacognition (see Metacognition). Before developing metacognitive skills, a simple representational ability has to develop, that is object representation, which includes having the understanding that an object (or person) that moves out of sight still exists and can be recalled and represented as an internal image. Then the ability to slightly transform represented objects will develop, e.g. drinking from an empty cup or letting one object substitute another, as when a stick becomes a horse. More advanced pretense demands a more consolidated representational system, for instance substitution, in which something with a conventional function (e.g., a book) can represent something totally different (a pillow) can only be performed by older preschoolers. Older children will have more advanced abilities at steering their imaginary process, in this case to suppress the conventional function of an object.

The *ability to steer the thought processes* purposefully to some extent involves executive functioning, meaning the control and regulation of actions and cognition performed by the prefrontal cortex. Some basic awareness of thinking – metacognition – is necessary to be able to deliberately switch between realistic thinking and imaginary and also to remain focused on a task (see Metacognition). Task-focus demands regulatory functions to not get distracted by irrelevant internal or external stimuli. Research by Johannes Golchert et al. (2017) indicated that daydreaming can also be more or less regulated. The deliberate form of daydreaming is more related to individuals’ intentions and involves not only default-mode activity but also integration with prefrontal brain areas, whereas the more uncontrolled spontaneous daydreaming do not demonstrate the same prefrontal activation. So the development of imagination and the ability to use the capacity intentionally will demand some form of integration between the default-mode network and prefrontal areas.

The development of the ability to *distinguish between reality and fantasy* is another important step for acquiring imagination, and many scholars, for instance Bretherton and Beeghly (1989), argue that it is practiced through make-believe and sociodramatic play in childhood. When socio-dramatic play involves the immersion into a fantasy world together with others, children need to simultaneously direct the play. Metacommunication with the other players means going out of the play sphere and in the real sphere giving stage directions, for instance: “now the heroine was hungry, so she took an apple from a tree.” Then when acting it out after having switched back into the role character in the play world, pretending to eat the apple by letting a ball be a substitute for the apple.

The development of metacognitive capacity is involved in the process of teasing apart imagination and reality, individuals’ separation of their own beliefs and others’ experiences, and the awareness of their own thinking and their imaginary processes.

However, even if the ability to distinguish between reality and imagination has been acquired, situations also occur when there is a blurred line between real and pretend actions. For young children, emotionally loaded pretend content, can become “too real”, for instance when a parent enacts a monster, the child may become actually scared. For adults too, fictional presentations can evoke strong feelings, indicating that the spheres are never fully detached. The real world also intrudes into the play world at times. If an additional child wants to join the play, new roles will need to be invented to suit the new number of players and if someone falls and gets wounded, the plot might be changed to include a visit to a herb woman who can heal the wound.

Modelling the World Through Pretend Play

Why is the development of imagination important for children? In the pretend play world, children deal with their experiences by creating model situations and they learn to master reality by experimenting in the play world. Children both relive experiences and make up alternatives to reality in make-belief play and through this activity, they have eventually built a useful representational model of their world, which helps them handling their everyday reality. In interviews with 26 children, Hoff (2013) found several functions of imaginary friends. Children used their imaginary companions as inner mentors and more specifically the make-believe friends helped the children feel less lonely and motivated the children to do scary or difficult things. The imaginary friends thus served as symbols for company, comfort, and encouragement. Some children also reported having imaginary companions of opposite characters to themselves, which seemed to support an experimentation with alternative selves that might assist children’s identity development.

However, having established a firm grip on reality, does not mean that the ability to transform and reinvent reality in imaginary processes disappears. Imagination will continue into adult life in the form of daydreams, cultural appreciations and, for some individuals, professional works of art. In fact, as suggested by Bretherton and Beeghly, the goals of authors and playwrights resemble

objectives pursued by children in their pretend worlds. Several famous authors, such as the Brontë sisters, created elaborated imaginary worlds as children. An imaginary world involves a long-lasting elaboration and development of a pretend space, with which the child is consistent over time concerning its contents, such as its imaginary people, places and artefacts. The imaginary world matters to the child and is something the child takes pride in. Such childhood imaginary experiences often serve as inspiration for adult artists' work.

Adult Imagination

Imagination is not merely a childhood activity, but rather an essential part of many adult capacities, such as in the preparation of new tasks, in making choices between different possible roads by simulating different outcomes, but also in the combination of various knowledge and experiences into new ways of solving problems. Also, in situations when there is no immediate use for the imagination, it can function as entertainment in order to bear a tedious task.

Recent research suggests that the default-mode network and its subsystems, that provide the substrate for day-dreaming, consumes a majority of the brain's energy. In his research studies, [Eric Klinger \(2013\)](#) had his participants estimate the percentage of waking thought that was daydream-like and they reported about 30%–50%. Klinger suggested that this capacity has evolutionary reasons to exist, that it must have benefits for the species survival.

There are, however, also costs. Research studies indicate that adaptive and maladaptive manifestations of daydreaming varies broadly across individuals. Several mental health disorders include problems arising from daydreaming. Not only the content of daydreaming and its relations to well-being are different, but also the amount and control of imaginative thought varies across individuals. Even if an average person spends up to half their waking time daydreaming, there are also groups of people, for whom the imagination is totally lacking and individuals with psychiatric illnesses, for whom the line between reality and imagination is vague and whose inability to distinguish what is real and what is intruding imaginary content is a defining symptom.

Fantasy Proneness and Uncontrolled Imagination

There is great variation in how much people use their imagination. [Judith Rhue and Stephen Lynn \(1987\)](#) explored extreme fantasizers in the normal population, and termed the personality syndrome *fantasy proneness*. Fantasy proneness means a deep long-lasting involvement in imagination and their sample of college students represented the upper 3% on an imagination scale.

The fantasizers were compared with low-fantasizers (lower 3% of the same scale). There are at least two roads, from which high fantasy involvement develops. For some fantasizers, the imagination involvement is life embellishment inspired by highly fantasy-involved role models and for others, it is a form of coping with traumatic events or an aversive environment. The fantasizers told about parental encouragement for fantasy involvement and engagement in cultural activities, but only the encouragement to read stories discriminated fantasizers from low-fantasizers.

Childhoods of fantasy-prone individuals more often contained loneliness and also abuse compared with low-fantasizers. However, at the same time as the fantasizers reported more physical punishment, they also described a greater use of imagination to cope with the pain. Despite reports of abuse, the fantasizers assessed their home environment as positively as the low-fantasizers. Lynn and Rhue suggested that fantasy may serve a functional role in maintaining a positive view of the family.

Fantasizing may also serve other adaptive and compensatory functions in relation to the individuals' reports of loneliness. More of the fantasy-prone individuals asserted that they preferred solitary play over play with friends compared with the low-fantasizers. Despite these distinct childhood patterns, the high and low group were equal on measures for psychological well-being, social adjustment and college performance. In adulthood, the rich imagination of the fantasy-prone individuals seemed to function as escape from the constraints of reality, as a channel to handle anger, and to regulate other emotions.

There are also variation in how much control individuals have over their imaginary processes. Recent research by [Golchert et al. \(2017\)](#), compared spontaneous daydreamers with deliberate daydreamers. Spontaneous daydreamers reported attention deficits more frequently and reacted more to their internal experiences. The deliberate daydreamers modulated their daydreaming in relation to if they were involved in easy or demanding tasks. When involved in easy tasks, the individuals could afford daydreaming without performance costs and therefore engage in daydreaming, but in challenging tasks they constrained their thinking in order to concentrate on the external task.

There are also pathologic mental disorders that are related to uncontrolled imagination, such as dissociation and schizophrenia. In these disorders, the diagnosed individuals no longer have the ability to distinguish what is a product of their imagination and what is real.

Dissociation means that an individual detaches from their experiences, predominantly as a way to handle conflicts or adversities. In severe cases, the detachment is so complete that the individual has different personalities for different experiences and cannot merge these into one coherent self.

[Kathryn Becker-Blease \(2013\)](#) distinguished between pathological dissociation and non-pathological dissociation. The non-pathological dissociation is also referred to as absorption or just fantasy proneness. Pathological dissociation often develops from normal childhood imaginative and dissociative processes but due to a history of child abuse becomes a maladaptive coping style.

Moreover, pathological dissociation includes memory disturbances, distorted perception and confused identity, so that individuals who suffer from it may have difficulties remembering significant events, such as their wedding, and may not be able to recognize themselves in the mirror. The line between pathological and non-pathological dissociation is, however, not always clear as

people with non-pathological dissociation are deeply involved in their imagination and to some extent may live in an imaginary world of their own, partly because of an inability to cope with reality. There are also creative people who make use of their imagination and dissociation in productive ways in their work who show similar symptoms as those diagnosed with pathological dissociation. However, Becker-Blase identified some discrete signs of pathology, which include that an individual has several different personality states that are experienced as distinct with separate memories that only can be accessed during one of the states, and that the individual is not able to move between these states deliberately.

In schizophrenia, individuals have lost the sense of reality, which means that the line between reality and imagination is confused (just like with other less long-lasting psychotic illnesses). Together with reality distortion, individuals with schizophrenia often experience dissociation; and have a history of trauma, of being bullied or abused, or of social adversity. These antecedents are often part of the cause for the illness in interaction with genetic factors. Schizophrenia symptoms include hearing voices (and other hallucinations), believing in delusions and paranoid thinking, speaking in ways that is difficult for others to follow (termed *thought disturbances*) as well as so called *negative symptoms*, which includes emotional withdrawal and apathy (see Schizotypy).

Both dissociation disorder and schizophrenia are examples of when the imaginative capacity cannot be used adaptively, because the imaginative contents become as real as the objective world and the individuals react to internal and external stimuli with no ability to differentiate between them. However, there are not just people with uncontrollable imagination but also those that suffer from impoverished imagination.

Lack of Imagination

Different people will have different levels of imagination, and for some individuals, the imaginative capacity is constrained. For some, it depends on environmental reasons and for others, disorders or injuries led to reduced imagination.

There are children growing up in socially disadvantaged environments but also those from families that discourage fantasy-involvement who may suffer from impoverished imagination. However, research found that play therapy can be used to train the imaginative ability. In her seminal study, Sara Smilansky (1968) showed that a nine-week socio-dramatic play intervention could improve children's ability for role playing. The study compared 800 children divided in experimental and control groups. The children came from both advantaged and disadvantaged backgrounds, and both groups demonstrated benefits from the intervention. For some individuals, the imaginative deficits were more enduring.

One of the diagnostic criteria for autism spectrum disorder is that the individuals find imaginative processes challenging. People suffering from autism spectrum disorder has been found to have default-mode network dysfunctions, something which seems to be part of explaining their deficits in social functioning. The default-mode network is also essential for meta-cognition, the capacity necessary to think about thinking and for understanding other people's mental states. Metacognition is also necessary for making up alternatives to reality in the imagination. However, the basic representational ability is not impaired in individuals with autism compared to typically developed individuals. Fiona Scott et al. (2013) in their research demonstrated that it is only the ability to form non-veridical images in their mind that appears to be impaired for individuals with autism. Individuals with autism also demonstrate significantly less pretend play (and also creativity) in comparison with either typically developed children or controls with Down syndrome.

The Role of Imagination in Human Functioning

Functions, Benefits, and Costs of Imagination

Because the default-mode network consumes a great amount of the brain energy, it has been suggested that this kind of processing serves important human functions. Some of the suggested functions of imagination involve its capacity to overcoming constraints, such as in planning future events and finding new and useful alternatives for action. Klinger also argued that direct or indirect daydreaming will be involved in successful goal-pursuit. Increased activation of daydreaming will occur when circumstances are unfavorable for goal-fulfilment, and then the daydreaming may relate to goals. When individuals are involved in external activities that are relevant for their goal-pursuit, daydreaming is typically reduced.

Another essential function of imagination is that it promotes creativity. There is also research demonstrating that imaginative people are better at delayed-gratification, meaning being able to wait longer for a reward. Moreover, a function of "off-line" imaginative thinking is that it appears to support memory consolidation, similar to what takes place during sleep, though the memory consolidation in daydreaming is not as efficient as in sleep (Klinger, 2013).

Imaginative processes can have different qualities that will influence individuals in various ways. Daydreams can be temporary flights from reality providing relaxation or being experienced as joyful for the individual. Daydreaming can also be experienced as frightening and compelling. There is a relationship between daydreaming content and mood as Andrews-Hanna et al. (2013) explored. Repetitive thinking of negative events, so called ruminations constitute a form of negative daydreaming that is linked to negative mood and depression. Negative moods influences thinking toward the processing of past events. It appears to be a vicious circle, in which ruminations produce more negative mood, which in its turn leads to even more thinking of the past. Negative daydreaming is characterized by being experienced as personally significant and is at the same time more abstract with fewer details. On the other hand, future-oriented thoughts are experienced as more positive. Andrews-Hanna found that reports of positive daydreaming content was associated with emotional health and wellbeing. Positive daydreams are characterized by more concrete details but are not as long-lasting nor self-focused as negative daydreams.

In a study with children, Hoff et al. (2019) found a link between positive fantasy contents for example, vivid and happy daydreams, and intrinsic mastery motivation, whereas negative fantasy content was associated with more externally driven avoidance motivation. Examples of negative fantasy content was scary daydreams and fantasies about monsters.

Thus, the content of fantasy and other imaginary processes seems to be decisive for different individual outcomes. Individuals who are able to regulate their imaginative thinking to include predominantly positive or productive content will be more likely to make the imaginary capacity function adaptively.

There are situations, in which attentional lapses in the form of daydreaming are not beneficial. It may concern reading, learning and the performance of other challenging tasks, which are activities demanding individuals to attend to the external world for a sustained period of time.

Nevertheless, for most individuals imaginative processes occur now and then. For individuals with poor metacognitive skills, such as those suffering from attention deficits, intruding internal thoughts (as well as external stimuli) are extremely difficult to regulate and this will lead to frequent task failure. At the same time, learning and working with demanding tasks often require an integration of information from the external environment with internal representations, for instance the retrieving of memories might support performance. It means that, some form of deliberate guidance of the imaginative content in goal-relevant lines may help successful task performance. In creativity tasks, the integration and flexible use of different kinds of thought (rational and imaginative) is essential.

The Relation Between Imagination and Creativity

Laypeople often mix up imagination with creativity and see the constructs as interchangeable. However, creativity refers to a capacity needed to achieve a product or idea that is both unusual and useful. In contrast, imaginative processes do not need to be unusual nor useful, even if they can be. Nevertheless, imagination can be described as a necessary part of the creative process. In the reflection and inspiration phase of the creative process, also termed the incubation phase, imagination is the most essential cognitive capacity, enabling broad inclusive thinking, whereas in other creative phases, such as in the realization and in the evaluation phase more focused and rational thinking is demanded (see Incubation, this volume).

Recent neuro-research pointed out that the integration of default-mode activity (thinking at rest) with more controlled functioning is important in order to spark creative insights. This deliberate daydreaming is decisive for instance, to achieve meaningful memory retrievals, which support the creative process. In fact, the psychodynamic researchers that the chapter started out with also asserted that creativity constituted an interplay between primary and secondary process thinking.

Thus, research implies a necessary *regulated flexibility* of the imaginative process in order to support creativity. It can be related to a discussion in the creativity field whether creativity is dependent on controlled or disinhibited cognition. Several creativity researchers have stressed disinhibition in order to reach the associations furthest away from the conventional answers. It could be exemplified by a divergent thinking task, in which participants are asked to give as many suggestions of how to use an empty milk carton. "Having things in it" will be produced early by most individuals and does not require much disinhibition, whereas "filling it with sand and use it as a doorstep" will be a later (more remote) suggestion and demands more imaginary disinhibited thinking (See Associative Theory).

Other scholars have described creativity as a combination of *variation* and *selective retention*, meaning that first, a more inspirational free-floating thinking (imaginative) will produce a number of new ideas. Then secondly, a more rational, possibly criteria-based, decision process will be necessary in order to make a choice between all the generated ideas. This selection process leads to the actualization and completion of the creative work, but is less dependent on imagination.

Apart from the widening process (divergent thinking), there are other kinds of creative process, such as combining, and restructuring. None of these processes would work without the integration of imagination with more logical thinking. In *widening processes*, as the milk carton task, regulated flexibility of different thinking modes will be necessary for the integration of expansive thinking in order to produce many unusual solutions (door stop), and cognitive control to reduce too disinhibited, deranged associations (see Divergent Thinking). *Combinatory processes* can be exemplified by a picture completion task, in which participants are asked to link given fragments and to produce their own original designs. This task also demands both the capacity to produce and follow spontaneous inkings as well as to constrain the process in order to reach an end "product", which means finishing the picture in a way that makes sense to others.

Finally, *restructuring processes* are used in so called insight problems. One example is the candle task, in which participants are given a candle, a box of thumbtacks and a matchbook and are asked to fixate and light the candle on a wall in a way so the wax does not drip on a table. Also, in this task, the integration of different thinking modes are decisive. First, disinhibited more exploratory imaginative thinking is necessary for participants to distance themselves from the immediate associate (sticking the candle to the wall with the tack) and to find other ways, such as the correct solution, which involves emptying the tack box and nailing it to the wall and then using the box as a candle holder. After having managed to restructure their thinking and overcome the functional fixation about the box as not just a container for the tacks, participants then are obliged to use more restrained thinking to finalize the task (see Insight).

Concluding Comments

Imagination research is prominent in many different fields, such as developmental and educational psychology, which investigate pretend play and sociodramatic play as well as imagination and its links to reading, learning and motivation. Moreover, research

within the field of neuropsychology expands the knowledge concerning brain functioning supporting the production of imagination and the research on the default-mode network is an interesting road. Within personality psychology and clinical psychology, individual differences are explored to understand what antecedents underlie the development of fantasy-proneness or impoverished imagination. No matter in what field imagination scholars work, there is a depth of knowledge to unravel concerning functions, relations, and benefits as well as costs of the imagination.

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Implicit Theories

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Introduction

Scientific theories have been constructed through multiple studies that are based on collecting and analyzing data. Because good scientific theories are articulated in ways that are testable and replicable, they are referred to as explicit theories. Over seven decades, creativity has been explored and explained through several kinds of explicit theories. Creativity has been psychometrically measured as part of *Structure of Intellect* (Guilford, 1967) and defined in terms of personality traits. Theories of cognitive processes underlying creativity were proposed and tested. Social psychology theories attempt to explain how people are facilitated by or interact with environmental factors to be creative. However, explicit theories do not perfectly characterize how people behave and make choices to be creative, despite the well-grounded evidence accumulated in scientific research.

In fact, people's personal beliefs about creativity affect their opinions and expectations of themselves and others. The naive beliefs about creativity held by "lay people" (those who do not scientifically study creativity) are referred to as implicit theories. These are merely personal and are not necessarily empirically tested. Implicit theories are as important as explicit theories because uncovering implicit theories helps to understand common-cultural views of particular groups reflecting their cultural and demographic values. Also, scientists with implicit theories may use these to guide their research of explicit theories. More importantly, people make judgments of creativity, adjust expectations of creativity in themselves as well as others, and even make decisions to be creative corresponding to their implicit theories. For instance, people put less effort into being creative if they believe creativity is innate and stable over time. Also, if people believe that artistic talent is a main component of creativity, they should enhance their artistic talent to be creative. The roles of implicit theories are critical when involved in the selection and placement of students. For instance, if teachers believe children who are good at drawing are more creative, they would allocate resources to enhance artistic experiences in the class. Similarly, if managers believe creativity is simply a different form of intelligence, they would recruit bright employees and expect them to be innovative in their work.

This entry reviews four topics: a) history of empirical research about implicit theories, b) misconceptions and the intricate nature of implicit theories, c) cultural differences, and d) methods to be used in implicit theory research which are followed by e) discussing three challenges and related opportunities.

History of Empirical Research About Implicit Theories

Since Torrance investigated teachers' beliefs about creative children in his seminal work in the early 1960s, implicit theories of creativity have been studied in various populations: teachers, parents, children, artists, scientists, college students, professionals, adults, and many other groups.

What Do Implicit Theories Look Like?

Among many populations, teachers have constantly received the most attention when examining implicit beliefs of creativity. It is not surprising given the major role that teachers play in identifying children's creative potential and making decisions in various educational settings. Among the approximately 39 studies about implicit theories found from 1963 to present in creativity

research, teachers' beliefs about creativity were investigated in 72% ($n = 28$) of the identified studies. Since the late 80s, parents' implicit theories (e.g., [Runco, 1989](#)) emerged in creativity research. Parents are as important as teachers in making decisions about children's educational placement. They are also equipped with the perspectives encompassing children's cognitive as well as social/emotional development in contexts beyond the classroom. In fact, [Runco \(1989\)](#) found that teachers' implicit theories of creativity focus on intellectual traits and that the perceived intellectual traits are highly related to their perception of motivational and attitudinal traits in children. The strong tie between creativity and intellectual traits in teachers' implicit theories was also demonstrated by high correlations between children's intelligence test scores and ratings by teachers ($r = 0.34-0.66$). In contrast, parents' implicit theories were marginally correlated ($r = 0.04-0.36$) to teachers' implicit theories and less dependent on intellectual traits. This is found in that none of attitudinal and motivational traits were significantly correlated with children's intelligence test scores. The differences were anticipated as parents and teachers are often unlike in their expectations for and experiences with children.

Although children themselves are the other important agent in making decisions regarding their educational opportunities, it was only later that children's implicit theories became a research focus (e.g., [Saunders Wickes and Ward, 2006](#)). [Saunders Wickes and Ward \(2006\)](#) found that gifted adolescents believed artistic talents, popularity, and questioning to be characteristics of creative people when they were asked to rate creativity in created profiles. Artistic talents were consistently reported when average and younger children were asked to define creativity. However, gifted adolescents seemed to apply different rules when they judged their own creativity believing that risk-taking, awkwardness, intellect, and impulsiveness were characteristics of creative people ([Saunders Wickes and Ward, 2006](#)).

What Factors Affect Formulation of Implicit Theories?

As described in the studies above, illustrating implicit theories helps us to more deeply understand what people's beliefs look like, but they do not necessarily explain why people choose to behave in certain ways. Recent research tends to focus on investigating to which factor people's implicit theories are attributed and how people's implicit theories are translated into their decisions about themselves and others. Still, teachers are targeted as the population of interest (e.g., [Gralewski and Karwowski, 2016](#); [Karwowski, 2007](#); [Paek and Sumners, 2017](#)). For instance, [Karwowski \(2007\)](#) found that teacher nomination of creative children is largely attributed to students' academic achievement and, therefore, is not necessarily indicative of children's creative potential. Teacher nomination is a subjective method of identification largely based on teachers' implicit theories of creativity. Thus, the finding implies that teachers' implicit theories of creativity may be partly confounded with their notion of good students. This finding was repeatedly affirmed in the previous literature ([Bachtold, 1974](#)). The misled implicit theories in teachers should be underlined because they potentially cut down the accuracy of recognizing students' creative potential ([Gralewski and Karwowski, 2016](#)).

How Do Implicit Theories Impact Identification and Development of Creativity?

Lately, practical impacts of implicit theories in teachers seem to drive research toward emphasizing probable consequences of teachers' implicit theories, going beyond describing what teachers' implicit theories look like. For instance, [Gralewski and Karwowski \(2016\)](#) conducted an explorative study classifying teachers into four groups based on their beliefs about creativity. They found that at least one-third (34%) of teachers hold implicit theories of creativity that failed to predict students' actual creativity. In other words, their implicit theories are not aligned with whom creative students really are. For instance, they rated key attributes of creative people, such as inventiveness, problem solving, and openness, all low. Their ratings imply the probable misconceptions that teachers hold about creative students. [Gralewski and Karwowski](#) also identified two other groups of teachers. One group consisted of teachers (19.8%) who perceived creativity as adaptive, valuing perseverance in addition to inventiveness and openness. The other group consisted of teachers (45.8%) who perceived creativity as more innovative and radical. Surprisingly, what teachers believed about creativity indeed affected their assessment of students' creativity. For instance, teachers tended to accurately assess creativity only in females if they perceived a creative student as an adaptor, while teachers tended to accurately assess creativity only in males if they perceived a creative student as an innovator. Put differently, teachers' gendered beliefs affect how they assess creative potential in students. Although their finding is tested in only 131 teachers, implying the lack of generalizability of the finding, it has been repeatedly affirmed that teachers' implicit theories of creativity may overlook students who may not match their prototype of creative students. More importantly, this oversight may disadvantage certain groups.

Teachers' implicit theories are determined by behavioral and academic functioning at school through achievement, friendliness, and discipline. The implicit theories may even vary by gender of students. If teachers' ratings of student creativity are derived from students' actual creativity, then teacher ratings of creativity in students should be highly correlated with students' actual creativity. Interestingly, teachers' creativity ratings reflect students' actual creativity only in boys but not in girls. This gendered difference implies that teachers tend to construe boys as creative and girls just as polite. Students' gender is one of many factors affecting teachers' implicit theories possibly producing disparity by groups in talent identification. Teachers' inaccurate implicit theories of creativity may be a concern particularly when students internalize these beliefs about creativity through their daily interaction with teachers in the class.

Misconceptions and Intricate Implicit Theories

Teachers' implicit theories specific to certain groups also appear in students with special attributes. Teachers tend to endorse that only select students can be creative (Aljughaiman and Mowrer-Reynolds, 2005). They believe creativity to be attributed to intellectual characteristics such as cleverness and intelligence and artistic attributes such as awareness of beauty and aesthetic products. In fact, high intelligence and artistic ability do not guarantee creativity as documented in the literature (Kim, 2008). This misalignment is not surprising as the discrepancy is well-documented between teachers' implicit theories about creativity and the attributes that creative children actually exhibit.

The discrepancy between implicit and explicit theories are often defined as misconceptions (Paek and Sumners, 2017; Paek et al., 2019). Teachers tend to show more misconceptions about personality characteristics of creative children. More specifically, Paek et al. (2019) found that it seemed difficult for teachers to tell what characteristics were not really indicative of creative children. This misconception tended to be apparent if the characteristics (i.e., sincere, honest, & well-mannered) were desirable in the classroom. Interestingly, these personality characteristics are not necessarily noticeable in creative people even when findings from 13,167 people across 83 studies were synthesized in Feist's (1998) meta-analysis. His synthesis indicated that creative people were more likely to be open to new experiences and flexible; more ambitious and impulsive; and more self-confident and hostile. Additionally, creative people were more likely to be anxious and emotional although these characteristics were specific to artists. In other words, teachers' prototypes of creative children may not necessarily match people who are actually creative, indicating teachers' probable misconceptions. Teachers' prototypes of creative children, and favoring ideal students, are repeatedly upheld in the literature (Bachtold, 1974; Paek et al., 2019). The prototypes may explain teachers' expectations for creative children to be curious, self-confident, or sincere but not to always ask questions, be naughty, or critical (Bachtold, 1974). As seen in the teachers' expectations, teachers may hold conflicting beliefs.

It is pretty unique to implicit theories of creativity that people, markedly teachers, simultaneously hold conflicting beliefs about creativity or creative children. Put differently, the conflicts imply a complexity and intricate nature of teachers' belief systems about creativity. The conflicting beliefs may explain why teachers use different standards for creative children. For instance, teachers tend to nominate ideal students (Gralewski and Karwowski, 2016; Karwowski, 2007) as creative, while they tend to use negative descriptors to describe creative children they have taught (Bachtold, 1974).

Conflicts are also found when teachers are asked about their beliefs of the nature of creativity. Paek and Sumners (2017) found that teachers simultaneously hold fixed and growth mindset toward creativity, in contrast to that people have either a fixed or a growth mindset regarding intelligence. Teachers are not the exception, because randomly selected adults simultaneously tend to hold both mindsets, too. Creative mindset refers to whether teachers believe creativity to be a fixed or changeable (i.e., growth) characteristic. Put differently, teachers tend to believe creativity is an innate talent if they believe that creativity is fixed. Thus, they are likely to believe that only those who have special talents (e.g., giftedness, high IQ, or artistic talents) can be creative (Aljughaiman and Mowrer-Reynolds, 2005). On the other hand, teachers tend to believe that creativity can be taught or developed over time if they believe that creativity is changeable. They are, in turn, likely to believe that everyone has the potential to be creative. Teachers' beliefs about creativity, in fact, impact their confidence in teaching for creativity. Stated simply, if teachers believe creativity is attributed to innate talents, teachers are less likely to believe that all children have potential to be creative. The more teachers believe that not all children have creative potential, the less likely they are to be optimistic about their ability to teach for creativity. This probable cause-and-effect chain was empirically examined by Paek and Sumners (2017).

Teachers' notions that children can develop their creativity over time may be contingent upon whether the children innately have special talents. This conditional notion appears to be a conflict in their beliefs. The notion also explains conflicts in how confident teachers perceive themselves as teaching for creativity: Teachers value children's creative potential but tend not to believe that they were able to teach for creativity. Similarly, Aljughaiman and Mowrer-Reynolds (2005) found that teachers feel pretty confident in teaching creativity but not in all students. Simply put, teachers believe that creativity can be taught by special teachers in select students, but not by themselves as well as not in all students.

Cultural Differences

Implicit theories reflect unique values of particular groups, as evident by similarities and distinctions in what they believe about creativity by groups (teachers vs. parents, regular students vs. gifted students). The group-specific values matter because implicit theories promote or inhibit creative behaviors mediated through value systems. Communities sharing different values, from demographic groups to cultures, are likely to hold different beliefs about creativity. Correspondingly, culture-specific implicit values may determine whether creative behaviors are encouraged and, specifically, what types of creative behaviors are encouraged. Research has grown in examining and comparing implicit theories specific to cultures since the early 2000s (e.g., Paletz and Peng, 2008) and continued recently (e.g., Paletz et al., 2011).

Paletz et al. (2011) tested the hypothesis that creativity is expressed differently in Eastern and Western cultures. Indeed, the results confirmed that cultural differences on individual foci versus collective foci were repeatedly found in the previous literature. In their study (Paletz et al., 2011), East Asians were more likely to perceive visible and interactive activities or traits (e.g., social interaction, sports, cooperation, extraversion) in social settings as creative, whereas Caucasians were more likely to perceive internal activities and traits (e.g., thinking, designing, intelligence, depression) and internal professions (e.g., artist, philosopher, and

spiritual person) as creative. This finding implies that Asians would portray a creative prototype as more externally sensitive/active. This may be explained by the generalization that Asians value and are more sensitized to social relationships and social impacts of creative outcomes. However, implicit theories are not always contrasting between Eastern versus Western cultures. [Paletz and Peng \(2008\)](#) attempted to test cultural differences in perceiving novelty and appropriateness when judging creativity of products. Novelty, which is known as a main component of creativity, obtained consensus across three countries (i.e., China, Japan, and United States). Another finding was contrasted to the common notion that Americans would not value appropriateness as much as they did for novelty; when appropriateness of products was manipulated, Americans' ratings on creativity of products were affected as much as they were in Japanese. Yet, Chinese's ratings were less affected by manipulating appropriateness. A single common theme may not simply explain all cultural differences in implicit theories partly because creativity is multidimensional and complex by nature. Culture-specific implicit theories are even more complex to study, as collective values may keep changing through interaction with cultural tradition along with societal changes.

Methods of Implicit Theory Research

Implicit theories are complicated and complex by their nature and consequently require the use of various methodological approaches: qualitative, quantitative, and even mixed depending upon the purpose of research.

Self-Report Open-Ended Questionnaires

Implicit theories cannot be uncovered unless "lay people" are directly asked about what they believe about creativity in their own words. The nature of research on implicit theories has driven researchers to describe the common themes arising from the interviews or open-ended questionnaires. Furthermore, an ethnographical approach has sometimes been taken to delve into teachers' perceptions about classroom environment facilitating children's creativity. Merely describing teachers' and parents' words indeed uncovers what they think but does not necessarily show which thoughts are more or less prevalent.

The summary and synthesis can be done in many different ways, not only qualitatively but also quantitatively. Quantifying the themes may help with counts, percentages, and ranks. When responses in open-ended or semi-structured questionnaires are counted and ranked, it is easier to see what thoughts are dominantly found in individual groups and even compare them across groups ([Aljughaiman and Reynolds, 2005](#)). Research documented on this topic has been used to construct instruments measuring implicit theories such as Adjectives Checklists of Creative People as found in many studies (e.g., [Karwowski, 2007, 2010](#); [Paek et al., 2019](#)).

Social Validation

Another interesting method is social validation ([Runco, 1989](#)). If we aim to diagnose and/or identify children with special needs, we might like to count on those who have plenty of experience with the children, no matter how much scientific knowledge they have about special needs. This technique is referred to as social validation ([Schreibman et al., 1981](#)). For instance, parents or undergraduate students with no training in special education are able to tell whether autistic children improved their behaviors before and after behavior therapy as much as trained judges ([Schreibman et al., 1981](#)). Schreibman et al. underline the social importance of treatment effects in autistic children. In other words, subjective ratings collectively done by naïve judges are as important as objective ratings by experts although their scientific knowledge is far different by its scope and depth. When it comes to social importance, creativity is not an exception. Significant others, such as parents and teachers, who have spent a substantially large amount of time with children may be more able to tell the social importance of creative potential that children exhibit, although their judgment may not be entirely corresponding to what has been scientifically affirmed.

Social validation has been commonly used in examining parents' and teachers' perceptions of creativity and creative children. Two phases are typically taken in the social validation methodology ([Runco, 1989](#)). In the first phase, teachers and parents are asked to define or illustrate creativity. Their responses are qualitatively described, or the frequency of words (or phrases) appeared in their responses are simply counted. Then, the summarized responses are used to construct a structured instrument to be used in the target groups. In the second phase, the instrument constructed in the first phase is further used in collecting quantitative ratings about creativity in other samples of the target groups (e.g., teachers or parents).

Advanced Analyses for Inferential Statistics

Beyond describing what teachers believe about creativity, research has employed inferential statistics ranging from regression analyses to item response theory. Regression analysis was performed to see what factors affected teachers' nomination of creative children ([Karwowski, 2007](#)). The results indicated that students' academic achievement was the main predictor, and students' creative attitudes and actual performance in a creativity test were not. Furthermore, confirmatory factor analysis was examined to identify latent factors underlying teachers' ratings of adjective checklists ([Karwowski, 2010](#)). It was confirmed that teachers' belief of personality characteristics exhibited in creative children consisted of five factors (i.e., dynamism, intellect, excitability, agreeableness, and conscientiousness). Further, the five factors were compared between creative and "well-behaved" students indicating that teachers

perceived creative students as more dynamic, intellectual, and excitable while less agreeable and conscientious compared to good students.

Personality characteristics were analyzed even at the item level using a Rasch analysis (Paek et al., 2019): The results indicated that teachers tended to show more misconceptions determining what are not the characteristics of creative students. This misconception was apparent when the characteristics were desired in the classrooms. More sophisticated factor-analytic techniques were further employed in this line of research. For instance, teachers were classified into four groups based on their beliefs on the six factors of personality characteristics of creative students using latent class analysis (Gralewski and Karwowski, 2016). The identified groups were further compared to see if they were different in their accuracy in assessing students' creativity. The consequences of teachers' beliefs of creativity in students was also tested in a moderated mediation model (Paek and Summers, 2017). Given the intricate nature of implicit theories about creativity, researchers need to continue to develop and use solid experimental design as well as innovative methodology in future research.

Challenges and Opportunities

In this section, challenges and opportunities are discussed. First, implicit theories have a long history encompassing many studies, which reveal that some implicit theories correspond to explicit theories, while many do not. Thus, it is of great interest how scientifically untested beliefs affect how people behave and make decisions in regard to being creative. This causal link has plenty of implications in helping people to correct their misconceptions and improve their daily practice to be creative. The majority of research asserts the probable impact of or mechanism underlying implicit theories based on self-report survey designs. This can be further tested in more rigorous ways including laboratory experiments. In many cases, it is challenging to study implicit theories because of its intricate nature, demonstrated by how many conflicting beliefs are entangled and interplay with one another. Given this intricate nature of implicit theories, conventional methodologies may not be able to fully discover how the beliefs are connected, interplay with one another, and even affect the way in which people behave. Thus, various methodologies quantifying people's beliefs and how they interplay are needed to extricate the complicated beliefs beyond simply illustrating or counting them.

No matter whether implicit theories correspond to explicit theories, they influence peoples' daily practice of creativity development. The influence tends to be more impactful in those who are still in the process of developing their creativity, such as in children. This is one of the reasons that educational settings have gained attention in implicit theory research. In contrast, less research has explored how creativity is perceived in other populations. For instance, how scientists perceive creativity is different from what engineers, or more dramatically, artists, perceive. Differences in implicit theories by profession may elicit characteristics unique to each domain, which might help to build a model explaining creativity specific to a domain. Implicit theories can be compared within a profession across a professional path; what engineering students perceive about creativity is likely different from what seasoned engineers perceive. Comparing the differences contributes to uncovering how domain-specific creativity is developed, how implicit theories affect its development, and what challenges people may encounter across a professional path.

Another challenge is that mixed evidence about creativity can be easily spread among the public. The media plays a big role in this dynamic. For instance, the "mad-genius" theory refers to the notion that creativity seems to be connected to negative aspects of mental illness. The mad-genius theory is often romanticized in the media and is prevalent in public discourse, as if the theory has been scientifically confirmed beyond dispute. Perhaps one of the reasons for this is that the romanticized notion may be profitable in the media although it is not empirically supported; Paek et al. (2016) synthesized 89 studies and found that common psychopathologies (e.g., anxiety, depression) were not really related to creativity in general and even negatively related to creativity when those psychopathologies were as serious as being diagnosed clinically. Despite the unsupported connection between them, the mad-genius belief affects how people perceive their own creativity. The stronger they believe in the mad-genius theory, the more likely they rate themselves more creative, whether or not they are actually creative. This finding indicates that a false belief discourages them to accurately estimate their creativity, which could impact how they allocate their efforts and resources to be creative. Therefore, scholarly endeavors are compelling in identifying prevalent misconceptions regarding creativity and informing the public.

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Improvisation

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It is the most normal thing in the world to improvise. We improvise every time we say a sentence, but we are told in our veneration of the masters that the creative process is some sort of mysterious and godlike thing only possessed by a few people – when in fact we are improvising all the time, creating all the time

Stephen Nachmanovitch (Quoted by Channing Gray, 1990).

When people encounter the word *improvisation* they readily think of music and, specifically, of Jazz music, where improvisation is a core element and highly valued. Yet, improvisation can be found in nearly any area of life and is a prevalent feature in many human activities; indeed, we all improvise on a daily basis, when we communicate with each other. This chapter is focused on creative improvisation and touches upon several aspects involved in improvisation as a unique form of creativity. It starts with defining and describing the concept of improvisation; then looks at improvisational creativity in different domains, starting with performing arts (music, theatre and dance), moving on to describe improvisation in martial arts and then to studies on the role and manifestation of improvisation within organizational and work context. The chapter finishes with a brief review of several studies pertaining to neural and cognitive aspects related to improvisation.

What Is Improvisation? Concept Definitions and Descriptions

On the one hand, as Nachmanovitch noted, improvisation is one of the most natural and prevalent human activities: most human interactions include improvisational elements. On the other hand, improvisation is a unique form of creativity, considered a desirable and, somewhat illusive skill, not only in a host of artistic domains ranging from music to theatre to dance but also in many various professional and organizational areas. This apparent contradiction is part of what makes improvisation an interesting and somewhat complex area of study.

To start, it would be instructive to examine the etymology of the word, going back to its Latin origins: *provisus* means foreseen or provided for (in advance), whereas 'im' indicates a negation or opposite of the word that follows. Hence, *improvisus* is something that is unforeseen, not prepared beforehand. According to Cambridge Dictionary (Improvisation, 2019), improvisation is "a performance that is not practiced and that is invented by the performers" and "the activity of making or doing something that you have not planned, using whatever you find." While the first definition is limited to performance, mainly in music, the second definition pertains to a broader set of activities. Yet, both definitions are not sufficiently exhaustive in describing the range of actions and phenomena where improvisation can take place.

Improvisation differs from many other types of creative performance in that, in improvisation, *the process is the product*. Unlike a scientific or artistic project in which the process of creating leads to some kind of end-product (tangible or not), in which the trials and errors along the way are usually 'edited out' and, generally, do not constitute an explicit part of the final outcome, for the improviser, the creative path is the end (Eisenberg & Thompson, 2003).

Gridley (1985) stated that "to improvise is to compose and perform simultaneously" (p. 4). Brownell (1994), who conducted research on drum-set improvisation in jazz, brought several other definitions: the first one by Horsley, who defined improvisation as "the creation of musical work, as it is being performed," and a somewhat different one by Tirro: "the somewhat mystical art of performing music as an immediate reproduction of simultaneous mental processes" (p. 28).

Sawyer (2000a) sees improvisation as an element of performance genres where there isn't prescriptive notation and he includes verbal-based as well as music-based genres in this area. He gives ritual, gossip, negotiations greetings and conversation as examples of verbal genres that fall under improvisation.

Sawyer holds a non-dichotomic view on improvisation; that is, rather than classifying creative endeavors into improvised and non-improvised, he sees improvisation as a relative quality or characteristic of performance. Writing about verbal improvisation, he believes that “improvisation is not an absolute, but rather a relative term, and is always in a dialectic with the pre-existing structures of verbal performance” (p. 121). To answer the question of what makes a performance more or less improvisational, Sawyer suggested a multi-criteria approach with seven dimensions along which performance genres can be contrasted, with each dimension indicating a more ritualized vs. improvisational character: *Ossification*, a term borrowed from anatomy, refers to how archaic versus contemporary is the language used; *Involvement of audience*, where more improvised genres tend to include more interaction with and participation of audience in the performance; *Resistance of genre to change*, with more improvisational genres being more open to change and innovation; *Permanence of genre change*, which indicates that while changes are more likely to occur in highly improvisational genres, these changes do not persist; *Cultural valuation*, with more ritualized genres gaining higher social and cultural value than improvised genres; *Indexicality and metapragmatics*: Sawyer said that in more improvised genres speakers make higher use of references to specific elements in the performance itself and reflecting on their own performance while performing it; *Breadth of genre definition* refers to more improvised genres having a broader or more tolerant approach to include variety of performance elements, where such diversity is more likely to be treated as error in more ritualized performance genres.

Sawyer’s typology is a useful and sophisticated approach to compare the degree of improvisation in certain performance genres. Questions remain as to how useful this approach would be outside linguistically based performance genres, such as music, organisational improvisation or improvisation in dance and movement. Also, a further discussion is needed as to which of these dimensions are more crucial and important in certain performance genres; it is likely that some of the dimensions would be more relevant for some performance domains than others. For example, in certain artistic and social sub-cultures, such as Hip hop and, specifically, in the freestyling kind of Rap music, improvisation is an essential element of the performance and, thus, the dimension of cultural valuation may not function in it at the same way as it would in classical music.

Improvisation in Music

Most people tend to associate the term improvisation with music-related performance. Musical performance necessitates a set of motor and cognitive skills that are somewhat different from those required for performing well in other artistic domains (Gabrielsson, 1999; Thompson, 2009). Within musical performance, improvisation represents a specific sort of performance, typified by a combination of both high technical skills as well as originality (Pressing, 1988; Sawyer, 1992).

There are several characteristics which distinguish improvisation from other forms of creative musical activity. Gridley (1985) characterized improvised music as spontaneous, unrehearsed, and not written-down. Musical improvisation differs from other musical performances in that it does not require the performer to remember or follow set music and, unlike in most other musical performance, the absence of musical score that serves as benchmark for evaluating the characteristics of performed music. More than in other musical performance genres, innovation and originality are central and explicit goal among improvisers who try to avoid drawing on musical patterns or repeating rehearsed music.

Acknowledging that all performances include at least some degree of improvisation because not all the parameters of music can be fully specified in a musical score, Thompson (2009) tried to answer the question as to what, specifically, distinguishes musical improvisation from other musical genres. To that end, he employs the distinction between primary and secondary parameters of music. Performers of typical music are mostly limited to alter secondary parameters of music, such as loudness, timing, timber and tempo. In contrast, improvisation musicians show their skill in working with altering primary parameters, such as pitch, harmony and rhythm. By expressively manipulating primary parameters, improvisers create music that is more unique and original than music performed by musicians who interpret existing musical text. At the same time, Thompson reminded us that even improvised music is not completely original since it has to be based on some knowledge of existing music. He pointed out that the question as to how improvisers convert their memories of past music into new and original music performance is still not sufficiently answered and is a potent area for future research.

Brownell (1994) added another point: improvisation is mainly a practice which is being learned through personal experimentation and by oral tradition as opposed to structured written manuals and organized pedagogical materials, which characterize more the learning process of more “structured” musical performance.

Becker (2000) discussed the issue of etiquette in improvisation, that incorporates the notion of respect, that musicians show towards each other as well as the audience. He described how that respect may be lost by fellow musicians when a member is taking too much time and space improvising or ignoring completely others’ input as well as when egalitarian principles, which Becker argues are dominant in Jazz music, are violated. Audiences can perceive lack of respect in improvisation when musicians seem to ignore the audience reactions and focus on playing with each other.

Although Jazz is, by far, the musical style most associated with musical improvisation, improvisation in music is not limited to Jazz. Among the musical styles that emerged in more modern times, Rap music includes multiple occasions where improvisation is enacted; specifically, *Freestyle* rap is an improvisation style that is performed with or without instrumental beats and where lyrics are recited without strict planning or fixed structure. Definitions of what freestyle rap is vary and are often informal, as befits a performance area that only fairly recently became a subject of academic studies. Hisama (2016) noted that the definition of freestyle changed from the 1980s when it initially was used to refer to rap that wasn’t focused on a specific topic, emphasizing the random aspects of verbalization. In more recent years, freestyle is more specifically referring to rap that has not been written or prepared in

advance, thus, emphasizing the spontaneous nature of the performance: “Freestyle is you being spontaneous [he snaps]: right now. Improvise: *right now*, On the spot” (Rifleman, in a documentary film by Fitzgerald, 2004, quoted by Hisama, 2016).

Most performances are solo and, typically, a strong emphasis is placed on rhyming verses. While the performance itself is typically solo, it is most often performed in a group context, akin to a jam session, called *Cipher*, where a group of people stand in a circle and take turns improvising rhymes, typically informally. A specific variation is a freestyle battle, where performers compete to establish who is best, with the audience determining the winner. Interestingly, in freestyle rap, not unlike in Jazz, the question has received attention as to what type of creativity underlies improvisation: a pure spontaneous act versus mostly spontaneous performance but one that is based on preparation. Some freestylers noted that their art is a craft that involves training and continual work to “transform words into coherent verbal expressions” (p. 251, Hisama).

While various aspects of music performance received considerable attention by psychologists, there have been only a few empirical studies of music improvisation in the social sciences and even fewer that looked at improvisation from a psychological perspective. One reason may be that it is more difficult to capture and study a dynamic process of creativity than it is to study a product of creative process.

In a study of improvisational creativity in jazz, Sawyer (1992, 1999) conducted a series of interviews with professional jazz musicians. While he focused on *small jazz groups*, his observations and discussion are relevant to other forms of musical improvisation as well. Sawyer identified three critical aspects of improvisation, as follows:

- 1) *Interactional influences*: in improvisational performance, the social group is present and contributing to the creative act, as it occurs. In jazz, the social-environmental context strongly influences the nature of the improvisation, including the musical structure.
- 2) *Conscious and nonconscious processes*: Many improvisational musicians express preference for a mental state during the performance in which the ‘intellectual’ side is minimized. In comparison to composition, improvisation, evidently, relies more on ‘intuitive creativity’ versus ‘analytic creativity’ (though jazz musicians definitely use the latter one as well).
- 3) *The balance of structure and innovation in the domain*: in music improvisation, innovation is the primary goal and ‘breaking the rules’ is recognized as essential to creative jazz performance. Nevertheless, the musicians are aware of rules for how to innovate, as well. The salience of the tension between ‘breaking the rules’ and, on the other hand, accepting the rules about *how to break the rules*, distinguishes jazz from other artistic and scientific fields.

Music improvisation is typically learned through personal experimentation and only rarely through written manuals and pedagogical materials, which are commonly found in learning processes of more ‘structured’ musical performances, such as classical music. While, until recently, it was rarely taught in a systematic way in music education programs (Thompson, 2009) increasingly, improvisation is treated as an important skill in music education. For example, McPherson (1993), after examining a test that measures improvisational skill, noted a positive correlation between improvisational ability and performance proficiency.

Following an extensive review of historical, ethnomusicological, and psychological evidence, Pressing (1987, 1988) proposed a cognitive model in which improvisation is construed as an ordered sequence of ‘event clusters’. Each event cluster may be associated with previous events but is also shaped by current goals. Two strategies of continuing an improvisation are used: *associative generation* and *interrupt generation*. In associative generation, the performer continues the improvisation by introducing materials that are either similar to or contrasting with previous event clusters. In interrupt generation, the performer introduces novel musical ideas that are unrelated (neither similar, nor contrasting) to previous events.

Improvisation in Theatre and Comedy

Improvisation in theatre appeared in ancient times, such as the Atellan Farce performances during the ancient Rome periods; however, as a distinct and developed genre, improvisational theater and comedy, often referred to as *Improv*, predominantly developed during the second half of the 20th century. In improv, most or all what is performed is unplanned or unscripted but, rather, created spontaneously by the actors/performers. Improvisational acting can be found in comic or non-comic variety, in stand-up comedy, in theatre plays, in psychodrama workshops, and in sections of filmed content (e.g., scenes in *Taxi Driver* and *Good Will Hunting*).

In theatre, Spolin (1999) was among the early pioneers of improvisational performance styles and also created techniques that can be used to develop improvisational skills among actors. A specific genre of theatrical improvisation is the political improvisation emerged in several countries, such as Poland (Jerzy Grotowski) and South America (Augusto Boal’s *Theatre of the Oppressed* Boal, 1993).

Building on Spolin’s work, improv comedy was later developed, initially in the US, then spreading to other countries and continents. Improv comedy sometimes takes suggestions or ideas from the audience to shape the performance. Improvisation is also often used by stand-up comedians who perform solo in clubs; while most of what stand-up comedians perform is pre-rehearsed and planned, some comedians integrate spontaneous elements, including interaction with the audience and as a way to deal with hecklers.

A core principle in improvisational comedy is known as “Yes, and ...”. Yes, and ... refers to the norm that a performer is expected to accept what another performer said or suggested and then build upon it in their own performance, resulting in a collaborative creative scene. The “Yes, and ...” principle distinguishes improv theatre from more traditional theater forms, where actors follow pre-determined scripts. While improv theatre is very flexibly in terms of structure and content, it is not without structural elements,

which can be classified into *external* and *internal*. External structure is shaped by suggestions from the audience and the type of venue and event that the improv takes place in. Internal structure, in contrast, is not obvious or evident to the external audience and is informed by 'rules' and principles known to the actors alone.

The 'Yes, and' principle is supported by several such 'rules', found in many theatre improv performances: refraining from judging one's own and other's ideas, active listening, and thinking without pre-determined criteria (that is, being open to various interpretations of an act or verbal information; [Moshavi, 2001](#)). Chicago's Second City, one of the most influential comedy theatres in the world, adopted and further developed these 'rules' into theatrical techniques.

Improvisation in Dance

Improvisation in dance can be found in various traditions, eras and cultures including Argentine Tango, Spanish Flamenco, Middle-Eastern Belly Dance, Indian tala, American Break Dance and Blues Dance and western-originated modern dance ([Carter, 2000](#)). However, the most radical form of improvisation can be found in a dance genre called Contact Improvisation (often referred to as *contact* or CI in the dancing circles).

Contact Improvisation typically involves a duet of dancers (though it can be performed as solo dance or in groups as large as ten or more dancers) who move together without agreed choreography or pre-planned script. They respond to each other's movements while spontaneously generating and creating their own way of moving with the partner, with themselves and in the specific space they are in. Contact dancing can be performed with or without music but, almost always, without speaking (which supports a better presence to one's own movement ideas and to the partner's movement). Dancing in Contact is a radical form of movement improvisation as there are no roles and no fixed rules and, ultimately, no expectations of what the next move would entail. The framework is very flexible and, while there are no fixed rules (nor agreed definitions) of what Contact is, most experienced CI dancers practice some of the following qualities: being active and reflexive, harmonic and spontaneous. Dance partners may engage in diverse forms of bodily contact through different parts of their body with an emphasis on high connection of body and mind and maintaining high levels of conscious touch. Dance actions may involve rolling on the floor or on objects (e.g., chairs), rolling on each other, pushing, sharing and taking each other's weight, jumping, falling.

The quality of a Contact dance is hard to evaluate by external standards though observers note differing outcomes of originality, harmony and flow among the dancers. While certain basic physical ability is helpful in mastering CI, prior formal dancing practice can be both an advantage as well as disadvantage since dancers often bring the set roles and movement they learned into CI, thereby curtailing their availability to improvise and flow with whichever move that comes from their partner. As a movement partnership that can get very physical, advance CI practice necessitates high levels of trust and awareness, supported by interpreting and acting on continuous multi-sensory feedback. Since its initial development as an experimental modern dance in 1970s, CI has spread from the US to many other countries and practiced in different levels of intensity, often taking the form of a *jam*, which is an informal contact dance gathering ([Carter, 2000](#)).

Improvisation in Martial Arts

While most martial arts combine well-rehearsed elements with improvised movement and response, the opportunity and, indeed, the necessity, to engage in improvisation is at its most in sparring practice or competitions. Most martial arts forms practiced today were developed in East Asia, with the majority coming from either Japan (e.g., Judo, Karate, Aikido) or in China (e.g., Kong Fu, Wushu). Training in most martial arts is based on mastering well defined moves and motions, often in sets of moves and rehearsal of attack-response sets. Not unlike in dance and music, improvisation in martial arts necessitates not only a certain state of mind but a high level of skill and practice. Effective martial arts improvisation can only be practiced once after extensive training and certain level of mastery.

A good example of martial art system where improvisation is built-in systematically into training is Bujinkan, an international martial arts organization, which was founded by Masaaki Hatsumi, who serves as its current head. Bujinkan is based in Japan and comprises several schools that are based on modern adaptations of samurai martial art tactics, where students learn to master techniques based on several underlying principles that include timing, distance, angle, strikes, locks and throws. Thus, students first master predefined sets of movements known as *Kata* and undergo physical conditioning. Once they progress and are skilled enough, they are encouraged to engage in what is called *Henka* in Japanese. *Henka* refers to a quality that is improvisation like, where practitioners engage in variations on the fixed routines in order to respond effectively to changes in the attacker's movement and situation. Putting the kata and henka training into practice is done through Randori, a free form training aimed at simulating realistic combat situations. Randori training involves spontaneous responses and dynamic techniques where the defender uses various means to disarm or control the attacker ([Hatsumi and Cole, 2001](#)). According to an advanced student of Bujinkan: "The experience of training with Hatsumi Sensei in Japan is that he never really does the same thing twice. He tends to explore a principle and formulate many variations around a central core." ([Fakhfakh, 2019](#)).

In the modern and eclectic martial art Cheng Hsin, which was created by Peter Ralston by incorporating Zen principles and techniques from Tai Chi, Aikido, Pa Kua, Judo and Western Boxing. In Cheng Hsin, improvisation is encouraged from early training stages. Students are encouraged to explore freeform movement applying the principles of keeping a calm mind, relaxed body, grounding, and moving the whole body as one. Reminiscent of contact improvisation, Ralston

developed a set of game-like practices to train students in developing flexibility when interacting with another person. Through gradual increases in intensity and speed, these freeform games turn into sparring (Fakhfakh, 2019; Ralston, 1999).

Improvisation at Work and in Organizational Context

Until relatively recently, improvisation, was mostly studied in the context of some sort of artistic performance; however, in the last couple of decades, improvisation has been increasingly appearing in work and organization studies. One of the reasons that improvisation has only relatively recently become a focus of study and research in organizational studies is that, traditionally, the emphasis in most organizational theories has been on elements of order and control; even the term itself, 'organization', brings to mind concepts of order and conscious organizing. This emphasis on ordered and planned dynamics and actions left out of the discussion many work related aspects that don't fit into this well-organized theoretical framework (Weick, 1998). I suggest that the increased popularity of discussing organizations in terms of improvisation and employing metaphors that are based on the worlds of music and theatre improvisation is due to the increased emphasis, both in organisational academic studies as well as in practice, on creativity and innovation, flexibility and timely and agile response to rapidly changing economic, organizational and social environments.

Weick (1998) suggested theoretical tools to understand improvisation and used concepts from Jazz improvisation to shed light on organizational improvisation dynamics. He discussed how improvisation as a practice ranges in degrees, with increased demands on imagination and concentration. These gradations, that exist in musical performance, can be applied to organizations in describing dynamics that take place during the development of new products, a process rife with change and innovation. Because improvisation dynamics lead to faster ability to tackle changes and result in creativity and innovation, an organization that learns how to improvise, holds a sustainable competitive advantage.

Moorman and Miner (1998) laid foundations for the concept of *organizational improvisation*, which they defined as "the degree to which the composition and execution of an action converge in time" (p. 698). They suggested that organizational skill knowledge (procedural memory) and knowledge of facts (declarative memory) moderate the impact that improvisation has on organizational outcomes. They stated that improvisation influences organizational memory by (A) generating experiments and (B) creating a context where improvisation competency skills can be developed. The authors observed that technological change influences the value of organizational improvisation and, furthermore, organizations' ability to substantially alter organizational memory's content and access effectiveness. They concluded that procedural memory enhances improvisational effectiveness and speed, while reducing its novelty. Declarative knowledge, on the other hand, enhances improvisational effectiveness and novelty, while reducing its speed. Thus, to achieve optimal benefits of improvisation, an organization should develop competencies in both types of memory.

Some organizational scholars attempted to move beyond the often-used Jazz-based metaphors when discussing organizational improvisation. Kamoche et al. (2003) warned against the reliance a single phenomenon when developing a new theoretical area; they suggested that organizational improvisation theories should look to Indian music improvisation, in addition to the traditional Jazz-as-metaphor, to create a more complete and accurate models. The Indian music model would be especially relevant for managers who aim to create specific parameters within which improvisation by followers would occur or when a competitive atmosphere is sought. On the other hand, they recommended that managers use the music therapy model when managers wish to create an innovation culture in a dysfunctional organizational culture where initiative-taking and decision-making are hampered and where skill levels are relatively low.

Fisher and Barrett (2019) emphasize the importance for organization scholars to focus on the experience of improvising because improvisation is an important source of creativity, which became a crucial element of many organizations' performance and, even, survival. They contrast improvisational process with compositional process, pointing out that while composition has been modeled as moving through certain phases, mostly in a linear fashion, improvisational processes are at odds with such phase models because the purposes of actions aren't well-defined in advance but, rather, next steps emerge as actions unfold and goals become clear only in retrospect. They observe that, like in music and theatre, improvising at work is risky because "improvisers test the limits of their own capabilities and sometimes fail in embarrassing ways." (p. 151). They suggest that it is the danger of failure that makes improvisation simultaneously exhilarating and perilous. While improvisation brings with it excitement in various work roles, they warn that constantly improvising on the job can lead to burnout and, sometimes, to successful improvisers resigning as the demand to constantly improvise becomes more tedious than exhilarating. They conclude that "The experience of ideating and enacting without the possibility of revision is central to understanding what improvisation is. That experience is both fearful and exhilarating, holding within it the possibility of both transcendence and failure." (p. 159).

A recent study by Secchi et al. (2019) was the first to describe and assess Service Improvisation Competence, a new construct that constitutes a novel way to improve customer experience in high-contact service contexts. Serv-IC is "the systemic ability of a service firm's employees to deviate from established service delivery processes and routines to respond in a timely manner to unforeseen events using available resources." (p. 1329). Studying the hotel industry authors found that while service improvisation competence had a strong positive impact on customer satisfaction in lower-level hotels (1–3 stars) it had only a weak relationship to customer satisfaction in elite hotels (4–5 stars).

Neuro-Cognitive Aspects of Improvisation

Substances Affecting Improvisation

Consumption of Cannabis products is part of several musical sub-cultures and many musicians reported that their musical performance is enhanced through cannabis use (typically in the form of marijuana smoking). Some jazz musicians reported that marijuana facilitates improvisation. Thompson (2009) suggested that this effect may relate to the effect of marijuana on time perception, which often seems to slow down. This effect has been validated in the lab, where participants tend to overestimate the amount of time passed in time perception tasks. Some jazz improvisers claim that this altered time perception gives them greater insight into “the space between the notes.” The subjective experience of this altered time is that musicians perceive that they have more time to make spontaneous musical decisions. “There may be a partial neuropsychological explanation for this subjective experience. A marijuana high is experienced when the psychotropic compounds in cannabis (primarily THC) are metabolized by cannabinoid receptors in the brain. The cerebellum—long known to be implicated in time perception, particularly for the smaller time intervals important to music—is known as an area of the brain with high concentrations of cannabinoid receptors.” (Thompson, 2009, p. 176).

Cognitive and Somatic Aspects

Attention to the here and now and acute awareness to the presence of one’s improvisation partners appears as a cross-cutting theme in music, dance and martial arts. Effective collective improvisation requires that each member of the improvising collective (e.g., dance group, Jazz band) pays attention, in real time, to what others in that group are doing, while performing their own part. Becker (2000) refers to it as *Etiquette of Improvisation*, which is typified by “attentiveness, care and willingness to give ground and take direction from each other involved in that kind of improvisation”.

Related to the above, physical embodiment is central to several improvisation domains, especially in performing arts. Bourdieu uses the term *Habitus* in his discussion of persons’ participation in various activities, termed broadly (and metaphorically) as games. *Habitus* “means basically the embodied sensibility that makes possible structured improvisation” (Calhoun, 2003, p. 292). According to Bourdieu, Jazz musicians and other skilled improvisers can play well together without consciously following rules because they have developed the ability and skill to use their bodies and senses to effectively interact with other musicians in real time. As discussed in the present chapter, this ability to ‘let go of rules’ while ‘playing with others’ can be found in several areas such as martial arts and contact improvisation. The common theme is that to reach a state of seemingly effortless flow, performers need to rely both on developing technical skills as well as learning to be constantly aware of their senses and somatic information from their own body as well as others.

Spontaneity

Spontaneity is another element that appears in various discussions of improvisation; referring to the unplanned production or performance of art, music, movement or speech (Becker, 2000). Does the emphasis on spontaneity mean that there is no structure, or no planning involved in improvisation? Thompson characterized spontaneous creation of musical compositions as one of the core elements of improvisation in music saying that “some improvisers may try to minimize all musical planning prior to their improvisation and focus on spontaneous innovation.” (2009, p. 199). Sawyer (2000b) acknowledged that the concept of improvisation is “problematic” because structure is present in improvisation as well, but it is not clear how little structure would need to be present in order for something to qualify as improvisation. Sawyer’s conclusion, drawing predominantly on his performative and academic experience with music, is that “there is no sharp dividing line between “improvisation” and “not improvisation” but it is rather a continuum (p. 182, 2000b). The degree to which improvisation relies on structure vs. spontaneous creation is a ripe area for both theoretical as well as empirical future investigations.

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Incremental and Radical Creativity

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Introduction

Creativity is recognized as an essential skill for individuals and a necessity for both survival, development, and growth of organizations, but the question *what is creativity* is often answered in too many different ways or in very broad terms. For example, when we talk about famous creatives, like Einstein, or some radically new inventions like the iPhone or the light-bulb, creativity is often construed as a highly desirable, but often elusive phenomenon, with extremely high expectations and standards, and some mysteriousness surrounding the concept and the process leading to the creative outcome. At the same time, everyday creative ideas of ordinary people, which often provide a quick fix to a problem or just adapt a solution to make it more efficient, like using different colors to make objects more noticeable and increase safety, or creating a new sorting system, are equally valuable and necessary and may be considered equally novel and creative. In recent years, an explosion of research in different areas has explored a plethora of personality and contextual factors and the interactions among them that may facilitate or constrain creativity, but the results are mixed and inconsistent, and some of the conflicting findings may originate from this very broad definition, the homogeneous and uniform way we usually measure creativity and the fact that some studies do not capture the full spectrum of creative ideas but only radical (for example new inventions and patents) or only incremental (e.g. Ideas from a company suggestion system). In this respect, some differentiation of the different types of creativity may help us both explain the factors and processes that influence it, as well as stimulate more creative idea generation.

While creativity is often defined as the production of ideas about products, processes, or procedures that are novel or original and potentially useful or practical (e.g., Amabile, 1996), creative ideas can range from minor adaptations or changes in how work is performed to radical breakthroughs and completely new products (Madjar et al., 2011; Mumford and Gustafson, 1988). One emerging area of research considers creativity as not just one overarching construct (Madjar et al., 2011; Unsworth, 2001), but rather as comprised of two or more different types. These two types include a more incremental, adaptive creativity whereby small changes are made to existing products, processes, or solutions to create a novel and useful idea; and more radical creativity, in which new and revolutionary ideas are introduced to completely transform existing products or processes. Several influential studies have differentiated creative work that relies on familiar algorithms and minor adaptations from the creativity that depends on radical new discoveries. Other studies have differentiated the factors for radical and incremental innovations and between exploitation and exploration, adaptive and innovative thinking, so the idea that there are different types of creativity is not new. Creativity entails an idea that is both novel/original and potentially useful/practical, two very different criteria for idea evaluation. Depending on the prevailing or salient aspect of the creativity definition, an idea could be really novel and original or not so new but very practical and useful, thus to understand creativity better, it may be useful to classify it into different types, namely, radical and incremental. Madjar et al. (2011) have defined radical creativity as ideas that substantially differ from the existing practices of an organization. Highly radical ideas present new and set-breaking frameworks or processes. By contrast, incremental creativity implies few changes in the frameworks and offers only minor modifications to the existing practices and products but usually with substantial usefulness. Making this distinction between radical and incremental creativity may allow us to better recognize the importance and value of both and tailor the contextual factors to stimulate more one versus the other. In certain situation, an incrementally creative idea may provide a quick and very economical fix to a problem or at least assure efficiency in the solution - in others, incremental changes may not be enough and a radical breakthrough may be what we need. It is important for both creativity research and practice to make this distinction between incremental and radical creativity instead of grouping everything together as a way to untangle the complexity of the creativity phenomenon and to create a better and more useful framework that will allow us to understand the different factors influencing creativity.

Relation Between Radical and Incremental Creativity

While it is easy to define the two types based on the degree of novelty and usefulness that they entail, incremental and radical creativities are neither completely segregated concepts nor concepts that can compare in terms of superiority. While individuals exposed to the full range of creativity, for example in advertising agencies, may easily classify an idea as incremental or radical, people who do not have enough experience with creativity or who have not been acquainted with both radically new and incremental ideas may have a hard time differentiating them. It is important to point out that radical creativity, although often easier to recognize, is not necessarily more valuable than incremental - on the contrary, because of the reduced risks involved, organizations may sometimes seek and value incremental ideas more as they can easily see the value added they bring. Unlike incremental ideas, radically creative ideas are usually easily recognized as novel and sometimes, we see the initial idea as radically new but a lot more creativity (often of the incremental type) may actually be involved in the small modifications and improvements of this initial idea till a final complete outcome is reached. For example, as Malcolm Gladwell states "The modern disposable diaper was invented twice, first by Victor Mills and then by Carlyle Harmon and Billy Gene Harper" (Gladwell, 2001). While Mills is recognized as the "father of the disposable diaper" and he was the one who created the initial product, and later the market for disposable diapers in 1961, it was the absorbent polymers created by Harmon and Harper, which led to thousands and thousands of incremental changes of the materials used, absorbent capacity, shape, bulkiness of the diaper, which later affected their transportation, distribution, storage, price, quality and convenience. But while Mills is celebrated for the creation of the disposable diaper, the incremental changes due to the small size of the new absorbent polymer created by Harmon and Harper are usually not recognized as a big accomplishment, while they are the ones, which added the most value (Gladwell, 2001).

In addition, in certain situations, a radically innovative outcome could be achieved by a series of incremental modifications and changes. For example, the new Nest thermostat, as a product, is nothing new and is still fundamentally having exactly the same function as the traditional old-fashion thermostat, but by incorporating the use of smart technologies, additional sensors and intelligent algorithms, it understands consumer preferences and can communicate to other devices. Through these small modifications, the company has created a new market for thermostats and a radically different "connected user" experience. Google's Gmail is another example of incremental creativity and innovation. When it was initially launched, Gmail had limited features but delivered emails well. Over time Google released more features and made the service better, faster, and easier to use and improvements continue to happen, so comparing the original and the current gmail, one may characterize them as radically different, although this was achieved through very gradual and incremental changes. As these examples illustrate, incremental ideas are not about huge sweeping changes, they usually improve an existing process or product, making it more efficient or cost effective. Radical ideas on the other hand, although rare, may suggest a completely new product, or a completely new delivery system (Blockbuster vs. Netflix) and may be disruptive to a company or a whole industry.

An idea or other creative outcome could be characterized as either incremental or radical, and the two concepts are seen as orthogonal and associated with differential pathways (e.g., processes and boundaries). The interpretation of the situation and its requirements and the approach and motivation that prompt incremental creativity are expected to be different from the factors that directly induce radical creativity (Amabile, 1996). At the same time, a series of incremental ideas and changes (e.g., changing colors [from pastel to bright], sound, and music; changing the individuals targeted [college students vs. retired baby boomers]) could eventually lead to a radically different advertising scheme. Ford (1996) has suggested that creative and habitual actions are competing behavioral options and incremental and radical are two types of creativity that pertain to behavior outputs that are manifested differently as individuals cope with a problem or situation. Kirton (1976, 1994) proposed that the difference between incremental and radical creativities probably stems from the different creative styles of individuals. Employees with adaptive styles work within the existing structures to make incremental changes and — do things better. By contrast, employees with innovative styles treat the current structures as part of the problem and create more radical changes by — doing things differently (Kirton, 1976). To further our understating of the creativity construct, it is important to not only classify ideas as incremental and radical but at the same time understand the antecedents and processes promoting one type of creativity more than the other and what follows is a brief summary of what we know about the differences.

Antecedents and Processes Leading to Radical and Incremental Creativity

One of the reasons for differentiating radical and incremental creativity are the important differences in how certain conditions may influence different creative processes. Oldham and Cummings (1996) for example, find differential results for two types of creativity measures (ideas from an employee suggestion system and patent disclosures) and argue that one explanation for these differences may be that their two measures captured different types of creativity, and the radical versus incremental distinction that appears in the innovation literature may hold with respect to individual-level creativity as well. A better understanding of the factors and processes contributing to radical versus incremental ideas may enable organizations to conditionally encourage or discourage radical or incremental creativity in their employees, align their work factors in order to achieve their desired goal (i.e., radical or incremental creativity). For example, within an organization, managers in an R&D department might want to have processes in place that foster and encourage radical creativity. In contrast, the managers of an accounting department may prefer to encourage incremental creativity and help their employees seek ways to improve on what is currently being done. Establishing the desired

conditions for appropriate idea radicalness should more effectively motivate employee idea production that is both supported, recognized and appreciated by managers and leaders and useful to an organization.

It is important to understand the motivational mechanisms as well as the personal and contextual factors that influence the engagement and the different cognitive processes involved in generating incremental vs. radical ideas. More specifically, identifying the factors that represent social and contextual influences, or personality characteristics, that may prompt the schema or frame of reference for interpretation of a situation may be critical. These factors may influence both the individual's interpretation of the situation or issue at hand and, consequently, involvement in radical creativity vs incremental creativity, as well as the processes used to generate these ideas. In addition to the motivating factors, the established models of personal and contextual influences on creativity (Amabile et al., 1996; Woodman et al., 1993) suggest other conditions that may influence the development and sharing of more radical creative ideas but have little or no effect on incremental creativity and vice versa (George, 2007). For example, factors that promote change or are more individualistic in nature, like resources for creativity, willingness to take risks, and career commitment, have a stronger association with radical creativity than with incremental creativity. At the same time, factors like organizational identification, presence of creative coworkers, and conformity, which have an element of loyalty, followership, and compliance (e.g., Miron et al., 2004; Zhou, 2003), are ones that may encourage incremental modifications rather than radical changes.

Intrinsic Versus Extrinsic Motivation and Incremental and Radical Creativity

One of the most important determinants of the radical vs. incremental creativity divide may be the reason or motivation for engaging in creativity. A lot of the creativity literature has explored intrinsic motivation, or the excitement for idea generation, the wish to engage in creativity for its own sake, or the desire to solve problems creatively as an internal drive for creativity (Unsworth, 2001). In contrast, a requirement from the job or problem at hand, the available bonuses and rewards, or the pressure for a solution to an existing problem, may provide an external drive and "force" an individual to engage in creativity. Although both the external and the internal motivators should result in creativity, some research suggests that the type of creative ideas generated may be very different, and this may be why there are mixed results regarding the effect of intrinsic and extrinsic motivation on creativity. A possible reason for the previous conflicting findings may lie in the unitary measurement approach to creativity, with differences in radical versus incremental creativity obscured. For radical creativity, deeper processing, experimentation, and more mental persistence should be a key driver, whereas for incremental creativity, the reward or external driver may be a key motivating force. These differences in underlying motivation are important because as others have suggested (Amabile, 1996; Unsworth, 2001), intrinsic motivation will be more likely to facilitate the kind of cognitive processes necessary to yield radical creativity. On the other hand, external sources of motivation (e.g., external rewards and supervisor behavior or the pressure of the competition or the problematic situation) may have the potential to undermine intrinsic motivation (Amabile, 1996). In contrast, incremental creativity should be less dependent on deep cognitive processes and, in fact, may benefit from motivational factors that discourage deep thinking. Therefore, external motivators that draw attention to the continual search for adaptations, refinements, and improvement are likely to be more effective for incremental creativity. Reward or other external motivators signal that the change is desired and should encourage employees to seek creative alternatives, even if they are not inclined to do it on their own, thus extrinsic motivators may be a good way to stimulate incremental creativity.

Resources for Creativity

Resources for creativity are considered very broadly here and may encompass financial, material and expertise resources or the mere time, access to diverse information and leadership support, as well as self-esteem, and skills to think strategically and creatively. Previous studies have identified the availability of resources in organizations as a determinant of the level of creativity and innovation (Amabile, 1996; Damanpour, 1991). In other words, resources are needed to support both idea generation and idea sharing and implementation. Constrained resources will diminish both the ability and the motivation to come up with new ideas as individuals will not have the time nor freedom to be creative or will not see potential for the implementation of their ideas. Lack of resources for creativity is often a signal from the organization that radically new ideas are not valued there but the empirical results linking resources and creativity are rather mixed. From one side, both the generation and sharing of radical ideas require more resources (more diverse expertise, more time, more financial means to experiment) and involve more risks when shared, thus the availability of additional resources is needed to buffer these risks and stimulate radical idea generation. On the other side, most incremental ideas require fewer resources and effort to be implemented than disruptive or radical ideas, thus may benefit little from slack resources. Limited resources, while a constraint for radical ideas, may actually create the necessity for small adaptations and modifications in order to produce quick and efficient results without the need for additional means. Lack of resources may be seen as the reason for discovering new opportunities and a way to motivate creative problem-solution involving incremental ideas. Thus, the availability of resources for creativity in an organization, including non-financial resources as access to informational and emotional support and diverse information, may be a critical determinant for radical vs. incremental ideas.

Association With Different Groups and Social Context for Incremental and Radical Creativity

Even if the motivation is right and the resources for creativity are available, these may be necessary but not sufficient conditions for engaging in radical idea generation. Creativity, and especially radical creativity, is considered risky and to take the additional risk, individuals need to feel that they belong to a group that accepts their radical ideas, provides the necessary emotional and informational support for them, and serves as role models for the desired creativity. Individuals who provide a sense of belonging and acceptance are necessary to encourage the engagement in creativity and in this respect, the social context and the sense of belonging, identification and commitment to different groups may be critical.

Identification and commitment are related to the incorporation of a group's beliefs and values into one's own identity and self-image and the binding of the individual to an organization or social group. Individuals usually identify and experience commitment to multiple social groups – their team, department, organization, professional group, as well as friend and family groups. Stronger identity and commitment to any of the work groups entails job engagement and desire to perform well, as well as loyalty to the status quo and some compliance to established practices. But the foci of this attachment to a social group (i.e., team or organization as a local entity or career/occupation with a more cosmopolitan orientation) and which one of them is more salient may determine the interpretation of the situation and its demands and, consequently, be the driver of behaviors or tailor individual efforts towards more adaptations and incremental creativity or radical ideas for big changes.

A salient group identification usually signifies easy and natural access and communication to that group's members as a source of information and knowledge as well as guidance and acceptance. If the group is local, it may serve as a strong source of information from within organizational boundaries. Within their unit or team or organization, individuals may find additional expertise and repositories of knowledge, skills, and abilities that can be used in creating solutions to similar problems, they can also borrow methods and processes they observe from their colleagues, especially if they strongly identify with them and this internal scanning for information may be very helpful for incremental idea generation (Jaussi and Randel, 2014). Organizational or team identification (a more local orientation), may at the same time be the driver of social pressure for loyalty and conformity to established values and routines, which, although beneficial for routine performance and incremental ideas, may also trigger more compliance and inhibit the desire to be involved in radical creativity. It is important to note that although organizational identification, especially with a creative company, may allow engagement in creative behaviors, it is still associated with certain organizational constraints (e.g., ideas are evaluated by established processes, need to be accepted, and must match a certain image or established reputation) that may inhibit radical creativity and lead to more incremental ideas.

Commitment to one's occupation/career represents attachment to a more cosmopolitan group. Career/professional commitment may provide a broader, more open perspective that may, in turn, cause individuals to interpret situations as opportunities for growth and creativity and may provide more options for action and a diversity of acceptable alternatives. These interpretations and created meanings may motivate a higher level of engagement in creative action and behaviors leading to change and may provide the necessary support and initiative that will enable radical change and innovativeness. A cosmopolitan orientation will facilitate external scanning for information about industry trends, economic and marketing perspective or other insights from competing companies (Jaussi and Randel, 2014). It may provide access to more nonredundant information that increases the pool of knowledge from which to generate creative solutions (Perry-Smith and Shalley, 2003). While information obtained from outside the organization may not seem all that relevant to a problem or issue at first, a high commitment to the professional group providing the information makes it salient and helps with the connections, thus holds the potential to spark ideas that extend beyond modifications of existing practices and are more radical.

High career commitment may also mean less social pressure to conform, whereas high attachment to an organizational or in-group unit, more proximal in location, represents more requirements and demands than open opportunities. Thus, a salient commitment and identification with a career/profession, or a more cosmopolitan group orientation and belonging is expected to have a stronger facilitating effect on radical creativity than on incremental ideas. These associations with external to the organization individuals may provide both the necessary sources of diverse information, as well as the support and easier acceptance of new ideas and solutions, which enable radical idea generation.

Conclusions

In sum, to advance both research and practice in managing creativity, it is important to differentiate its different dimensions, specifically, radical creativity where the novelty of ideas is prevalent and incremental creativity, where their potential usefulness is the defining factor. Furthermore, the antecedents to both types of creativity seem different and a distinct combination of individual and contextual variables such as extrinsic or intrinsic motivation, resources for creativity, organizational or career commitment among others can differentially influence the type of creativity exhibited (Gilson and Madjar, 2011; Madjar et al., 2011).

As some studies do not capture the full spectrum of creative ideas and focus only on radical or only incremental creativity, it is important to understand the whole complex picture in order to use this knowledge to foster the right creative ideas. The fact that the two types of creativity appear to be motivated by different drivers suggests that it is very important for organizations to figure out what type of performance they seek before they attempt to boost creativity using or modifying one of these factors. Understanding how certain factors play a role allows managers to tailor their policies and employees to engage in processes related to the desired by the organization type of creativity.

While the definitions of radical and incremental creativity seem clear, individuals with little experience and exposure to creativity may not be able to easily classify every idea coming their way. Runco (2014) outlined several problems with dichotomous representations of creativity, while others have expanded the classification to four instead of two types (Kaufman and Beghetto, 2009) but this classification is useful as a way to broaden the conceptualization of creativity and highlight the value of creative ideas with different magnitude.

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Incubation

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Historic Accounts of Incubation

Almost 100 years ago, the concept of incubation was popularized by [Graham Wallas \(1926\)](#), who made a landmark contribution with his book ‘The Art of Thought’, which helped to increase the understanding of the creative process. He coined terms that are still widely used today for four stages in the process: preparation, incubation, illumination, and verification. He conceptualized incubation as a stage in the creative process that follows hard conscious preparatory work involving acquiring knowledge and initial, unsuccessful attempts to come to a solution, and that ends at an impasse. At that time, the problem is set aside, and, in the following *incubation* period, the creator is no longer consciously working on the problem. The reason why the apparently uneventful incubation period of seeming cognitive inactivity has received so much attention in the creativity literature is, perhaps, best explained by what happens next: When the incubation period subsequently ends, it sometimes occurs in a sudden, satisfying, and surprising illumination or flash of insight that somehow resolves the issue at hand. Although illuminations may happen quickly, Wallas, in his original account, was quite fascinated with how one might sense—and become better at sensing—that an illumination might be near, a state he labelled “intimation”. The verification stage, which occurs when the creator is consciously thinking about the problem once more, ultimately involves evaluative processes and further work on the illuminated idea [cross reference Evaluative Processes].

[Wallas \(1926\)](#) derived his four stages of the creative process from anecdotal retrospective accounts by highly creative scientists, artists, and inventors producing creative contributions in their field. Indeed, anecdotal accounts of grand creators making breakthrough inventions, science, and art after spending time away from the problem are frequently quoted in the creativity literature (see The Four P’s of Creativity).

One of the most frequently cited anecdotal accounts of incubation comes from Henri Poincaré:

Just at this time, I left Caen, where I was living, to go on a geologic excursion under the auspices of the School of Mines. The incidents of the travel made me forget my mathematical work. Having reached Coutances, we entered an omnibus to go some place or other. At the moment when I put my foot on the step, the idea came to me, without anything in my former thoughts seeming to have paved the way for it, that the transformations I had used to define the Fuchsian functions were identical with those of non-Euclidian geometry. I did not verify the idea; I should not have had the time, as, upon taking my seat in the omnibus, I went on with a conversation already commenced, but I felt a perfect certainty. On my return to Caen, for conscience’ sake, I verified the result at my leisure.

Poincaré quoted in [Hadamard \(1945, p. 13\)](#)

This recollection by Poincaré has often been used to highlight that sometimes the creator is unable to identify “anything in their former thoughts” that generated the sudden shift from incubation to insight. However, other anecdotes in the literature can be used to show that is at least not always the case. Another frequently quoted anecdote involves Archimedes’ discovery of displacement after a long period of unsuccessfully trying to figure out how to estimate whether a crown was made of solid gold or not. The irregularity of the crown made it very difficult to estimate the crown’s volume, which would allow him to compare weight to volume. The story goes that, upon sinking into the water at the baths, Archimedes realized that he, by an external analogous event, had solved the problem—he could calculate the crown’s volume by putting it into a liquid and

then noting the level of displacement. The story goes that he subsequently jumped out of the tub and ran naked through the streets of Syracuse, shouting “Eureka” (I’ve found it).

The apparent triggering event does not always have to be external, as illustrated by another frequently cited anecdote involves Kekulé’s discovery of the molecular structure of Benzen while dozing in front of his fireplace. The nap came after difficult and cognitively demanding attempts to solve the problem, and, while dozing, he would find himself imagining the atoms still leaping about before his eyes. The story goes that he, in this dreamlike inner state, would imagine the atoms performing snake-like movements, upon which one of the snakes would begin biting its own tail. At that moment, Kekulé awoke in a flash, realizing that the molecular structure was a circular one!

A more recent anecdote involves the development of the Post It™ note at 3M by Arthur Fry. He was attending his church choir and became annoyed that his bookmarks kept falling out of his hymnal. In a sudden realization, he connected the issue with a new type of not-so-sticky adhesive developed by another 3M employee Spencer Silver that until then had not found its commercial use. The Post It™ was born. Although the creativity literature has focused on a limited number of these anecdotal accounts that seem to be endlessly repeated, a very large number of further incubation-like anecdotes can be found in the extant literature. Such anecdotes, however, tell little about the mechanisms behind the incubation phenomenon. As Boden (1990, p. 15) noted, what these anecdotes have described of the mechanisms behind incubation and insight can best be summed up as “the bath, the bed, the bus” (that is, they were sitting in the bath, lying in bed, or riding on a bus when all of a sudden ...). As such, the existence of anecdotal accounts should not lead to acceptance of the existence of the incubation phenomenon. After-the-fact introspective reports of mental processes are notoriously unreliable. In the case of Poincare, he based his own analysis of his creative process on the self-reporting of episodes that took place almost 30 years earlier.

Research by Howard Gruber on tracing idea development over time (e.g., through notebook studies of how Darwin developed the theory of evolution) has illustrated that often the creative process is a protracted construction taking place over years involving a multitude of small insights, rather than one overarching flash.

The anecdotal stories serve to illustrate the incubation phenomenon, but they do not prove the existence of such a phenomenon, nor do they prove that particular theories of incubation are true or false.

Theories of Incubation

A number of potential theoretical explanations for the incubation phenomenon have been proposed. These theories differ in several ways.

One notable difference between theories of incubation is whether the incubation period itself somehow provides *beneficial* steps towards a solution (e.g., by receiving cues from the environment or unconscious progress) or whether it simply helps recover a *temporary inability to make progress* (e.g., helping to overcome a temporary fixating state or inability to remember). Another notable distinction is whether the mechanisms involved in incubation are solely confined to the *autonomous* cognitive system (for example, conscious or unconscious work, overcoming fatigue) or to some *interaction* between cognition and environment (for example, encountering facilitating cues or the inability to make progress due to contextual fixating elements). It is important to note that the theories of incubation listed below need not be mutually exclusive and competing, as it is possible that there are many different ways in which the past inability to resolve problems may be overcome—thus, creating an incubation effect.

Below are some of the most well-known theories of incubation:

Unconscious Work

In his original account, Wallas suggested that active unconscious processing of the problem took place during the incubation stage. The term “incubation” is a biological metaphor suggesting that these unconscious processes “gradually mature” the solution. Much like the slow incubation of an egg ends with hatching a bird, the incubation of ideas ends in the “hatching” of the solution, in a sudden and surprising insight.

As noted by Wallas (1926, p. 86), “The Incubation stage covers two different things, of which the first is the negative fact that during Incubation we do not voluntarily or consciously think on a particular problem, and the second is the positive fact that a series of unconscious and involuntary (or foreconscious and forevoluntary) mental events may take place during the period.”

Variations of this theory of unconscious work have been proposed several times in the literature. Whether the mechanism is referred to as the unconscious, pre-conscious, or non- or off-conscious, it involves a solution being gradually developed that, in a next step, reaches conscious awareness. While theories of unconscious work are consistent with many anecdotal accounts, the theories rarely detail the mechanisms behind this unconscious processing, making them hard—maybe even impossible—to test experimentally. The lack of experimental testability led to suggestions that the theory of unconscious work should be put on hold until other more testable theories have been examined. Nevertheless, a theory on unconscious thought by Dijksterhuis and Meurs (2006) has suggested that, while conscious thought may be focused and convergent, unconscious thought is more associative and divergent. Furthermore, it has been suggested that mind-wandering may help explain incubation effects. Mind-wandering is a state of mind which occurs spontaneously and automatically when not engaged in cognitively demanding tasks and which seems to increase associative processing.

Facilitating Cues

The idea that facilitating cues or information from the environment is the cause of incubation effects has been proposed a number of times in the literature. It is usually accompanied by a theory that the mind is cognitively prepared to notice these cues—thus, epitomizing Louis Pasteur’s notion that “chance favors the prepared mind”. [Olton \(1979\)](#) argued that a basic way to demonstrate the facilitating nature of cues could simply consist of telling a problem solver the answer to the problem during incubation! However, he argued, more interesting and realistic results could be obtained by varying how “obvious” the cues given are in a series of research studies.

As it happens, this is exactly the path that the analogical problem solving literature has taken. It began with difficulties in demonstrating spontaneous transfer on distant analogies sharing mainly structural similarity (e.g., [Gick and Holyoak, 1980](#)), but later studies found a higher degree of spontaneous transfer when more obvious superficial similarity was shared between source and target. Analogical transfer ([Seifert et al., 1995](#)) or environmental cues triggering the retrieval of previously unretrieved relevant information or schemas (e.g., [Yaniv and Meyer, 1987](#); [Langley and Jones, 1988](#)) have been proposed as a cause of incubation effects several times. These prepared-mind theories have proposed various standard or non-standard cognitive mechanisms to explain why the environmental cues are noticed so that spontaneous transfer or retrieval can occur. These explanations include non-focal attention mechanisms ([Olton, 1979](#)), the encoding of so-called “failure-indices” in memory ([Seifert et al., 1995](#)), indexing and differential trace strength ([Langley and Jones, 1988](#)), and initial sub-threshold activation that is raised above threshold by external cues ([Yaniv and Meyer, 1987](#)).

Fixation-Forgetting

Another important theory of incubation explains incubation effects in terms of the creator forgetting fixating elements that prevent them from reaching a solution at first ([Smith, 1995](#)). [Smith \(1995\)](#) argued that incubation effects are caused by competing responses to a problem, which blocks the solution from being reached. These blocks lead to fixation, or “mental ruts”. Active work in trying to reach the solution only activates the blocker further. Following an impasse, there is a shifting accessibility of fixating elements and target (solution), with the target information increasing in relative accessibility to the fixating elements, thereby increasing the probability that the solution is reached when the creator returns to the problem. In other words, the fixating elements are forgotten upon returning to the problem. [Smith \(1995\)](#) also proposed that if the fixating elements were related to the context, contextual shifting—in addition to forgetting—during incubation may improve performance.

Conscious Work

One simple theory is that incubation effects are due to more conscious work (so-called “conscious recurrence”) done from time-to-time on the problem during incubation, which is later forgotten (e.g., [Woodworth and Schlosberg, 1954](#)).

Problem Space Forgetting

[Simon \(1966\)](#) hypothesized that incubation effects were due to selective forgetting. Using problem space theory, he hypothesized that, during problem solving, a goal tree is constantly being constructed and updated in the short-term memory at the same time as information about the problem environment is being familiarized and stored in the long-term memory. If the problem solver leaves the problem for a while (following impasse), the goal tree is quickly forgotten. If they later return to the problem, they will start off with only a higher-level goal (the finer details about the goal tree having been forgotten), but with better problem environment familiarization. Using this information, the new problem-solving session may, therefore, take new routes in the problem space and potentially quickly solve the problem.

Fatigue Dissipation

The fatigue dissipation theory simply holds that the pre-impasse active problem solving is very demanding work, and spending time away allows you to become rested and refreshed so that you will do better the next time you engage the problem. In addition to merely relieving fatigue, it has also been suggested that sleep may restructure new memory representations.

Low Cortical Arousal

Embodied theories of incubation have hypothesized the importance of arousal in incubation. [Martindale \(1990\)](#) proposed that creativity requires remote associative thought, which is best accomplished by defocused attention and a low state of cortical arousal, since this enables a large number of mental representations to be activated at the same time. Thus, a high state of cortical arousal (e.g., when engaging in the draining active search for solutions) may hinder problem solving because remote associations are weeded out by a narrow focus of attention. Setting the problem aside, therefore, increases the chances of creative discovery through lowered arousal levels, leading to defocused attention, which allows for remote associations (see Remote Associates).

Empirical Evidence of Incubation Effects

The extraordinary leap in problem solving, from seemingly conscious inactivity to sudden and surprising insight, is so impressive that it seems to suggest that the act of setting the problem aside somehow facilitated the problem solving (Olton, 1979). It is this alleged performance-enhancing feature of setting the problem aside that incubation researchers have focused on. Historically, the first published experimental study testing incubation defined it as “the spontaneous recurrence from time to time of an idea with more or less modification, while the subject is thinking of other topics” (Patrick, 1937, p. 81). The operational definition of incubation later changed to “laying a problem aside as a step toward solution” (Woodworth and Schlosberg, 1954, p. 838), which stresses the performance improving aspect of incubation. Later operational definitions on the incubation phenomenon have agreed that what needs to be explained is this performance improvement aspect of laying the problem aside, and it is now referred to as the “incubation effect” (see Problem Solving).

The theory that setting a problem aside for a while should improve performance is surprising, given what we know of human cognition and working memory, in particular. Well-known working memory effects, including rapid forgetting due to capacity limitations and fragility to distraction and interference, suggest that in so far as problem solving draws on working memory, it is surprising that putting the problem aside should improve performance. The opposite should be expected—it ought to be better to continue work in order to avoid rapid forgetting processes that occur after setting a problem aside, in part because re-familiarization and re-orientation (“now, where was I?”) with the problem should be required upon returning to the problem.

Experimental Studies

The most typical experimental lab design paradigm applied in incubation studies compares performance on creative problem solving between two groups, only one of which gets an “incubation” break away from active problem solving. The two groups are then compared in terms of their performance in the post-incubation period. Insofar, as the experimental group performs significantly better after the break than the control group, an incubation effect is said to occur.

In a comprehensive meta-analysis of 117 incubation effect studies, Sio and Ormerod (2009) found support for the existence of incubation effects, with a median effect size of 0.26. Their study identified important moderators to this overall effect, including the problem type, length of the preparation period, and the incubation task. Individuals solving creative problems (compared to linguistic or visual problems) were more likely to benefit from an incubation period. Longer preparation periods also gave rise to larger incubation effects. Interestingly, for linguistic problems, engaging in a task that has a low cognitive load (compared to either no task or a cognitively demanding task) during incubation led to the strongest incubation effects. The results thus support the existence of multiple different types of problem-specific incubation effects, as opposed to merely providing support for a singular theory of incubation. It seems that there are several distinct types of incubation effects caused by different mechanisms.

The finding that engaging in a cognitively undemanding task (relatively to a demanding task, rest, or no break) helps creative performance has been further supported in direct experimental tests of the role of mind wandering in incubation. A study by Baird et al. (2012) showed that engaging in undemanding tasks improved performance on the Unusual Uses Test far more than taking a break involving a demanding task, resting, or taking no break. This supports the idea that mind wandering may play an important role in incubation (see Mind Wandering).

The importance of the length of the preparation period shows the importance of the activity taking place prior to incubation in, perhaps, preparing the mind for later opportunistic encounters with chance cues or involvement in repeated problem-solving attempts under fixating conditions. In the meta-analysis by Sio and Ormerod (2009), neither introducing fixating elements nor presenting solution-relevant cues increased incubation effects across studies. However, incubation effects appear to be specific to the individual problem type, and it is possible that facilitating cues and introducing fixating elements only produce incubation effects for certain types of problems.

Accounts that the preparation period in effect functions to prepare the mind for later chance encounters with facilitating cues has received support in studies that utilize insight problems and analogous cues with a similar underlying problem-structure to the incubated problem. A study by Christensen and Schunn (2005) identified that, upon impasse, participants who were uninformed of the relation to the analogous cues more often than chance spontaneously accessed the incubated problem and used the cue to solve the problem. However, other studies utilizing Remote Associates Tests did not find that presenting facilitating cues during incubation increased solution rates.

Conversely, studies testing for the role of fixation in incubation have tended to use associative problems with a single correct answer, such as the Remote Associates Test (RAT). In these experiments, fixation is usually induced before the initial solution attempts at the problems, typically by presenting information that appears to resemble a solution to the problem but which is, in fact, a wrong answer. These studies indicated that incubation effects are likely to occur for people who are fixated. Putting the problem aside for a while, in this case, helps to forget the initially induced fixation that was present during the initial solution attempts. If the fixating elements are context-specific, then changing the context from initial work to the incubated period may also help alleviate the temporary fixating situation. Other fixation studies, however, which have used word completion tests or insight puzzles, have not found that fixating elements were the cause of incubation effects.

Overall, these results suggest that there are several problem-specific types of incubation effects. For creativity problems measuring fluency of production (i.e., the ability to produce multiple responses in a short amount of time, such as the Unusual Uses test), low cognitive load activity during incubation seems to help the production of more ideas post-incubation, which is likely

due to *mind wandering*. For creative problems aimed at finding one correct and remote solution amongst a number of associations (e.g. the RAT), introducing fixating initial elements tends to block the answer, and spending time away may help the creator to forget the fixating elements, leading to the solution (*fixation-forgetting*). However, introducing helpful cues—or even the answers themselves—on RAT problems are not likely to help resolve the problem. Conversely, for creative problems involving complex underlying problem structures, such as insight problems, the pre-incubation solution attempts before reaching an impasse help to mentally structure the problem and prepare the problem solver for later chance encounters with analogous solution elements. In the event the problem solver, by chance, encounters a solution element after having set aside the problem, the structural similarity to the unsolved problem will, at least sometimes, be noticed, and new solution attempts may follow (*facilitating cues*). However, in experiments using RAT problems, facilitating cues do not seem to be very helpful, likely because there is no structural problem pattern that can meaningfully be stored in memory for later recognition in the environment. The problem-specific nature of these distinct types of incubation effects suggest that there is no one correct theory of incubation—several of the incubation theories are, in fact, supported but only for distinct problem types, and these isolated effects often do not seem to generalize to other types of creative problems.

Future Studies

Unlike the historical accounts of incubation in which the problem was voluntarily set aside after reaching an impasse, many experiments testing for incubation effects interrupt the problem-solving process by forcing participants to either stop working on the problem or perform some other task at a time chosen by the experimenter. Following the distinctions between interruption types made by Jett and George (2003), it could be argued that incubation effect studies have typically examined “intrusions” (i.e., an unexpected encounter initiated by another person that interrupts the flow and continuity of an individual’s work and brings that work to a temporary halt). Contrary to intrusions, anecdotal accounts of incubation describe “breaks” (i.e., planned or spontaneous recesses from work on a task that interrupts the task’s flow and continuity, but which entails anticipated or self-initiated time away from performing work). It is, therefore, noteworthy that a majority of incubation effect studies tell us little about incubation conceptualized as breaks. In the domain of human-computer interactions and organizational psychology, it is well documented that—at least on complex tasks—intrusions have a negative effect on performance in terms of how quickly people perform the post-interruption task and the number of errors made. This implies that interrupting will produce some level of disruption so future studies should focus on further understanding the nature of self-initiated breaks away from the problem.

Given that incubation effects appear to be mainly problem-specific, it is important for future studies to test whether individual effects are generalizable across creative problem types. Furthermore, incubation effect studies operate under the assumption of a close relationship between creativity and incubation. However, it is possible that the problem-specific incubation effects generalize to similar non-creative problem types. In order to test for the assumption that the incubation effects are closely related to creative tasks, it is recommended that future studies also include non-creative tasks in their designs. In so far as non-creative problem solving centrally involve working memory, it is to be expected that incubation periods should disrupt problem solving performance (i.e., an inverse incubation effect where working continuously is beneficial). The contrast between non-creative and creative tasks will illustrate whether the incubation effect is specific to creative problems. It is further possible that, as inverse incubation effects are the “norm” on non-creative problems, then even a finding that a break neither disrupts nor benefits performance (i.e., a null effect) for creative problems would be theoretically interesting.

Summary

Anecdotal accounts by eminent artists, inventors, and scientists of the subjective experience of solving creative problems led to the idea that setting the problem aside for a while during an *incubation period* may help inspire its solution. The term “incubation” refers to the theory that unconscious processes may be operating in the period during which the problem solver is not consciously thinking about the problem. Much like an egg ends with the hatching of a bird, incubation sometimes ends in a sudden and surprising insight. However, several other theories have been proposed to explain the incubation phenomenon, including the forgetting of initially fixating elements and a mind prepared to notice facilitating environmental cues during the incubation period. Empirical evidence supports the existence of several problem-specific types of incubation effects. As such, there is no converging evidence for any single theory but, rather, support for several distinct causes of problem-specific effects. Incubation effects, therefore, come about due to a number of different mechanisms, including mind wandering, opportunistic encounters with facilitating cues, and the forgetting of fixating elements that have been preventing the solution.

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Relevant Website

Interruptions.net – List of publications on Interruption in Human-Computer Interactions; <https://en.wikipedia.org/wiki/Incubation>.

Innovation

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Innovation

Innovation is viewed as a critical source of organizational competitiveness and important for organizational survival in an increasingly turbulent environment. While researchers have reached consensus regarding the definition of creativity which is a solution, idea, or product that is both novel and useful, the definition of innovation, especially in relation to creativity, is still murky. Many researchers suggest that innovation is defined as the successful implementation of a creative idea. However, some submit that while creativity needs to be truly novel, innovation can be the adaptation of ideas in the current environment (so the idea is novel to the organization, but not completely novel). Others see innovation as a more inclusive term, encompassing both an ideas generation and its implementation. Finally, the most common approach views innovation as only the implementation aspect, excluding the idea generation and development phase (Anderson et al., 2014).

Common to all these definitions is the focus on the implementation of an idea, process, or product. Given the breadth of work devoted to understanding the early processes associated with idea generation, the focus of this article will be on the late processes of idea evaluation, idea selection, and implementation. Idea evaluation and selection are critical for creative problem-solving; in organizational settings, many ideas may be generated, but only a few of the ideas reach the implementation phase (West, 2002). Measurement of this latter stage varies from study to study and can take the form of accuracy of idea evaluation, choice of ideas to implement, and how successful the implementation process was.

Idea Evaluation and Idea Selection

During the idea generation phase, individuals and teams may generate a large number of ideas, especially if they are engaged in brainstorming (West, 2002). However, it is unrealistic that all of these ideas can be used and implemented. In fact, brainstorming rules require participants to suspend evaluation and not judge ideas, and therefore list any and all ideas. As a result, brainstorming and idea generation may result in a large number of ideas that need to be appraised and screened. Mumford et al. (2002) proposed that idea evaluation and selection include three major activities: forecasting possible consequences and outcomes of selecting and implementing an idea; judging how well the characteristics of an idea fit with specific standards and criteria; and choosing, revising, or rejecting the idea as a solution. Relative to the idea generation process, which is seen as mainly divergent in nature, the idea evaluation process is viewed as mainly convergent. However, it is important to note that idea evaluation, similar to other processes of creative thought, includes both convergent and divergent elements. For example, forecasting possible consequences includes a divergent component, as multiple potential consequences need to be thought about. However, judgments regarding how well ideas or solutions conform to specific standards are more convergent. While the research literature on idea evaluation and idea selection is more limited compared to that of idea generation, the research to date provides support for the importance of these processes for creativity and innovation and provides information regarding the factors that influence the application of these processes.

One of the most researched questions regarding idea evaluation is whether individuals and teams can evaluate ideas accurately, and the factors that influence accuracy. Some research suggests that people can evaluate ideas accurately for quality and originality, while other work has found that not all individuals can accurately evaluate ideas. For example, creative individuals tend to be more accurate in their evaluations. In addition, when people are asked to evaluate creativity as an overarching property of the idea, novelty of the idea tends to be a stronger predictor of the evaluation of creativity relative to usefulness, even though both are necessary for a creative idea. Finally, research suggests that participants tended to reject highly original or risky ideas more likely to select ideas that were consistent with social norms, easy to understand, and likely to quickly lead to desirable outcomes, especially under high time pressure.

Importantly, selection and evaluation are separate but related functions. Research that evaluated both idea evaluation and idea selection found that the participant evaluation predicted which ideas were selected. No individuals or teams chose ideas that they

themselves thought were not good ideas (scored high on quality). However, individuals and teams were not always accurate in their evaluations, resulting in the selection of ideas that they thought were good or creative, but that in fact were not so.

The relationship between idea generation and idea evaluation has also been considered. Many models of creative problem-solving suggest that the relationship is somewhat linear, ideas are generated, then evaluated, and individuals and teams potentially can return to idea generation if the results of idea evaluation are unsatisfactory. Early work suggested that engaging in evaluation during the generation phase could be detrimental, which is the foundation for the brainstorming rule of suspending evaluation. Research using artists indicated that the role of evaluation increased during the creative process, supporting this notion.

However, other work concluded that early evaluation may actually increase creativity. [Harvey and Kou \(2013\)](#) found that both may occur. Their work proposed that idea evaluation did not always follow from idea generation, and that in some cases, the two co-occurred. Harvey and Kou suggested that engagement in evaluation processes supports the development of a shared framework for the problem at hand and directs collective attention to ideas to guide feedback and decisions of how well ideas address the problem.

Team Influences on Innovation

Much of the work conducted to understand the factors that influence organizations in adopting innovation has focused on organizational determinants. Teams were studied as a context in which individuals can thrive and be creative ([Reiter-Palmon et al., 2008](#)). Team composition, specifically the diversity of the team, has long been considered an important factor that should facilitate creativity and innovation ([Hulsheger et al., 2009](#)). Early work in the area of team composition assumed that diversity in team composition would be beneficial resulting in increased creative output of teams, as a product of the diverse knowledge and experiences of the team members. In addition, it is expected that team diversity can contribute to the successful implementation of ideas and solutions as diverse teams can anticipate more of the potential obstacles in the implementation process and evaluate ideas more fully ([Reiter-Palmon et al., 2008](#)). However, research suggests that the impact of team diversity is much more complex ([Hulsheger et al., 2009](#); [Reiter-Palmon et al., 2011](#)).

Demographic diversity, that is, diversity based on factors such as age, race, gender, and so on, has not been consistently linked to improved creativity and innovation ([Reiter-Palmon et al., 2011](#)). While some research suggests that demographic diversity is beneficial, other work suggests no effects. Finally, some work found detrimental effects of demographic diversity of innovation. Most of the research on demographic diversity also evaluated each dimension of diversity (e.g., gender, age, race) on its own. Studies that evaluated multiple dimensions of creativity found that creativity and innovation were improved or hindered, depending on the dimension evaluated. To address these different results, several studies discovered that when team members and leaders valued diversity, diverse teams were more creative. These findings indicated that perceptions about the role and importance of diversity for creativity may also shape the effect that team diversity has on creativity.

In contrast to demographic diversity, differences based on attributes that are relevant to job performance, such as diversity in education, function in the organization, and job relevant knowledge, skills, and abilities, that is, functional diversity, were more likely to influence team creativity ([Hulsheger et al., 2009](#)). Research evaluating functional diversity found positive effects for functional diversity, suggesting that teams comprised of members from different and diverse functional backgrounds outperform homogeneous teams in terms of creativity and innovation.

The importance of functional diversity for innovation is in the breadth of informational and knowledge resources that different team members bring ([Reiter-Palmon et al., 2008](#)). However, in order to be able to use this information and knowledge, team members must be able to share the information and the team must be able to capitalize on the shared knowledge. As a result, it is not surprising that group processes that facilitate positive interactions, managing conflict effectively, psychological safety, and openness were particularly effective in enhancing innovation ([Reiter-Palmon et al., 2011](#)). Research suggests that team goals that emphasized collaboration and cooperation were related to new idea generation.

Communication, especially open communication, was also important for innovation. A meta-analysis by [Hulsheger et al. \(2009\)](#) found that internal communication was positively related to team creativity and innovation. In addition, the nature of the communication was important. Collaborative communication was related to higher creativity and innovation, whereas contentious communication was related to lower creativity and innovation. Psychological safety, which is defined as the shared belief that it is safe for individuals within the team to take interpersonal risks, also been facilitated effective and positive communication. Psychological safety was related to discussion of new ideas, making suggestions, idea generation, and importantly, to effective implementation of new ideas. West and his colleagues researched psychological safety in a series of studies across different industries and team types. Psychological safety was an important predictor of team innovation. However, a meta-analysis by [Hulsheger et al. \(2009\)](#) found that while psychological safety was predictive of team creativity and innovation, the relationship was weak.

Organizational Influences on Creativity

Organizational climate in particular has received attention as a contributing factor for innovation. [Hunter et al. \(2007\)](#) found that most frameworks included common dimensions such as positive relationships with peers, support from top management, challenge, autonomy, intellectual stimulation, and support for risk-taking. Similarly, a meta-analysis conducted by [Hunter et al. \(2007\)](#) concluded that these climate dimensions were related to creative performance of individuals and teams in the organization.

Further, the strongest climate dimensions were those related to having positive relationships, intellectual stimulation, and challenge. The importance of positive relationships is not surprising given the importance of social processes such as information sharing, communication, and trust for creativity and innovation. Intellectual stimulation and challenge speak to the importance of cognitive factors. Together, these findings indicate that a work environment in which people are presented with meaningful and challenging work and that allows for the exchange of thoughts and ideas is critical for creativity and innovation.

Leaders have long been viewed as important creators and transmitters of organizational climate. Leaders can help in facilitating more effective discussions, creating positive team interactions, which would lead to increased trust and psychological safety, which in turn will lead to improved communication and information exchange within the team. In addition, an important role for the leader in supporting innovation is removing obstacles—such as providing information, resources, administrative support, clarity, as well as serving as a champion for innovation. Leaders can also support innovation by facilitating workflow, work assignments, and autonomy, which have been linked to climate for innovation (Hunter et al., 2007).

Another important organizational factor that can influence innovation is resources. When discussing resources, it is important to note that a variety of resources should be considered. These resources include materials and funds, infrastructure and facilities, personnel quality and quantity, and time. The development and implementation of new ideas is time-consuming and can be expensive in terms of personnel, material, and time. Therefore, the availability of resources is likely to influence creativity and innovation.

Resource availability, especially financial resources, is related to adoption of innovation and innovative project success. Slack resources may facilitate creativity and innovation by allowing for experimenting, risk-taking, and working on multiple promising projects simultaneously. Slack resources also allow organizations to better prepare for changes in the environment and respond more successfully with innovation. However, while organizations that have resources available may be able to experiment and take risks, these organizations may be reluctant to do so.

On the other hand, resource constraints may facilitate creativity as organizations need to find creative ways to address problems while lacking resources. Specifically because they lack the resources, these companies must respond creatively and quickly to market and external forces to survive.

These contrasting findings suggest the possibility of a curvilinear relationship between resources and creativity. That is, slack resources will result in the organization not willing to develop and implement creative ideas as these are risky, or having too many ideas that are being developed. However, scarce resources will result in the organization not being able to develop and implement creative ideas due to limited funds and personnel. It is therefore important for organizations to evaluate what resources are available. On the one hand, too few resources may lead to difficulty in developing creative ideas, while too many resources may result in the development of many ideas, but ones of limited creativity.

Finally, organizational strategy is an important consideration, especially for the type of innovation that is pursued. Specifically, organizations can engage in exploration or exploitation (March 1991). Exploration is defined as the search for new ideas and products, developing new capabilities and is associated with risk-taking, experimentation, and flexibility. Exploration on the other hand is defined as refinement, implementation, and execution and is associated with capitalizing on known strengths of the organization. Research suggests that both strategies are important for innovation and organizational survival. However, exploration and exploitation have been associated with different kinds of innovation. Exploitation, due to its focus on exploiting current strengths, tends to be associated with incremental innovation, whereas exploitation, which focuses on searching for new capabilities, tends to be associated with radical innovation.

An important issue in the discussion of exploration and exploitation is whether these are two competing strategies or complementary ones. As both require investment of resources, some argue that organizations will be required to choose which strategy to use. However, organizational innovation and survival may be improved when both strategies are pursued simultaneously, noting that approach as ambidexterity (Zacher et al., 2016). Organizations, and leaders, that are able to manage this tension or paradox, by excelling in both exploration and exploitation, are more innovative.

Conclusion

Innovation is typically considered the criterion in most studies. While empirical research has looked at the effect of individual creativity and its effect on team creativity and innovation, only limited empirical work is available on the consequences of innovation. Much of that research focused on the organizational and financial consequences of innovation such as new products, increase in market share, and organizational adaptation and survival. It is therefore critical for researchers to also evaluate the outcomes of innovation for organizational survival and growth, as well as outcomes related to individuals and teams within the organization.

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Insight

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Insight in Problem Solving

Over the last 40 years, there has been a resurgence of interest in the notion of insight in creativity. The concept of insight in thinking was introduced by the Gestalt psychologists, early in the 20th century, in response to Thorndike's studies of habit formation in animals (Scheerer, 1963). Thorndike proposed that all behavioral advances came about through laborious trial and error, as the animal, starting with random responses, gradually worked out the sequence that would enable it to obtain food.

The Gestalt psychologists responded to Thorndike's theorizing by proposing that animals—and, by extension, humans—could solve problems through *insight*, on the basis of an understanding of the overall structure of a situation. In a famous series of studies, Köhler demonstrated that chimpanzees could produce complex solutions to problems, sometimes suddenly, as integrated wholes, without first working things out through "blind" trial and error. In the Gestalt view, if a problem was understood fully, then the thinker could produce a novel response that was not dependent on experience. For example, some of Köhler's chimps produced novel solutions to problems that were not related in any simple way to their experiences in similar situations. Wertheimer drew similar conclusions from studies of the performance of children on problems of various sorts.

Gestalt Theory

Gestalt theorizing about creative thinking was based on an analogy to perceptual processing. The sudden appearance of a complete solution to a problem was assumed to be brought about through mechanisms comparable to those underlying perception of a reversible figure, such as the reversible cube. The reversible cube suddenly switches from one interpretation, or structure, to another, as the person examines it. In a problem situation, also, more than one structure was possible. A problem existed because the person had structured the situation in a way that made solution unobtainable. In order for solution to occur, the person had to relinquish the initial analysis of the situation, which might allow a "re-structuring" to occur, which could bring about a new approach to the problem, and solution.

The core of the Gestalt analysis of thinking was the distinction between *reproductive* and *productive* thought. Reproductive thought, called *analytic thinking* by modern researchers, is based on the application of knowledge to a new situation. It might, in some circumstances, be successful. However, reproductive thinking could also result in the application of knowledge to a situation in which it did not fit, producing failure and impasse.

In order to deal with situations demanding true advances in thinking, it was necessary to put aside the past, and analytic thinking, and turn to productive thinking. Application of productive thinking to a problem involved several steps. First, reproductive thinking brought about a series of failures. Those failures would ultimately lead to an impasse, as the person exhausted possible solution methods based on reproductive thought. The occurrence of an impasse could serve to trigger a sudden restructuring of the

problem, resulting in a new perspective coming to mind. In the Gestalt analysis, restructuring was something that *happened to a person*, in a passive way, as the interpretation of the problem changed suddenly, in an Aha! experience. That restructuring was spontaneous, since it was out of the person's control. Again, the mechanism involved in restructuring a problem was assumed to be analogous to that which brought about spontaneous restructuring in perception.

The series of events that occurred when solving a problem through insight can be called the *insight sequence*:

problem $\Rightarrow$ impasse $\Rightarrow$ restructuring $\Rightarrow$ insight

It is still a critical component of modern formulations of Gestalt theory.

Classical Research in Support of Gestalt Theory

The emphasis on the need to relinquish the initial interpretation or structure of a problem, and replace it with a new one, served as the basis for a series of studies carried out by the Gestalt psychologists (Scheerer, 1963). Wertheimer studied insight in children, examining how his participants went beyond old methods, and moved to new interpretations of problems. Duncker carried out investigations of the thought processes involved in problem solving. He is best known for his research on *functional fixedness*, the demonstration that habitual uses of a common object can interfere with using it in a novel way in order to solve a problem. The most well-known of his investigations examined the candle problem, in which a candle must be affixed to the wall. An effective solution, one that is proposed infrequently, is to use a small cardboard box, which initially is holding tacks, as a shelf or candle holder. If the box is presented empty, it is frequently used, but presenting it filled with tacks interfered with that novel use. Maier also carried out several studies in which productive thinking was demanded. The most well-known of those studies centered on the two-string problem, in which the participant must tie together two out-of-reach strings. In Maier's analysis, the solution resulting from productive thinking involved constructing a pendulum, using a common object as the weight for the pendulum.

The strongest demonstration of the potential dangers in relying on experience to deal with the present was seen in the studies of mental set, carried out by Luchins and Luchins. In those studies, participants were presented with a series of mathematical problems, all of which were solved with the same relatively complex solution (*set* problems; all solved with the *set* solution). A series of *critical* problems were then presented, all of which were similar in appearance to the set problems. The critical problems could be solved using the set solution, but could also be solved using a much simpler *direct* method. Naïve participants, not exposed to the set problems, almost always solved the critical problems quickly, using the direct method. In contrast, participants with success solving the set problems solved the critical problems using the complicated solution, and were sometimes unable to solve a simple problem, to which the set solution did not apply. Experience with the set solution had blinded them to other methods, which naïve individuals saw immediately.

In sum, Gestalt theory argued that insight was the result of productive thinking. Insight came about as a result of relinquishing a reliance on experience, and organizing one's knowledge in new ways, to deal with the demands of a novel situation.

Development of Interest in Insight

Throughout most of the 20th century, Gestalt theory was not a dominant influence in psychology. Insight was typically included in discussions of thinking, but it was peripheral to, rather than a core component of, analyses of problem solving. An article by Scheerer (1963) in *Scientific American* can be seen as an attempt to bring Gestalt theory in general, and the notion of insight in particular, to the attention of researchers. However, Scheerer's article was not frequently cited until around 2000, when its citation rate almost quadrupled; and it has stayed at that level. What, then, explains the surge of interest in insight over recent years? That development can be traced to several studies, which raised questions about the usefulness of insight and restructuring as explanatory concepts in the analysis of thinking, and which tried to bring those concepts under the umbrella of mainstream experimental psychology. That critical discussion stimulated broad interest in the issues central to the Gestalt psychologists' analyses of thinking, with its focus on productive thinking, restructuring, and insight. Researchers supporting the Gestalt view responded to those challenges, by developing modern variations on Gestalt theory—*neo-Gestalt theory*—and providing experimental support for the neo-Gestalt views. The next several sections trace the historical development of those events.

Challenges to Gestalt Theory

In one study raising questions about insight, Perkins (1981) analyzed performance on the Antique Coin problem.

A stranger approached a museum curator and offered him an ancient bronze coin. The coin had an authentic appearance and was marked with the date "544 B.C." The curator had happily made acquisitions from suspicious sources before, but this time he promptly called the police and had the man arrested. Why?

This problem is an “insight” problem, presumably solvable only through restructuring and insight. An “analytic” problem, in contrast, is solvable through the direct application of one’s knowledge. In order to solve the Antique Coin problem, one must switch perspectives, away from that of the curator, to that of the person making the coin. How could the coin-maker have known that Christ would be born *544 years in the future*? The coin must be fake, and the man is a swindler. Perkins reported that “insight” into the solution came about as the result of the individual’s realizing the contradiction in the coin’s having the date “B.C.” printed on it. That realization was based on analytic thinking—the application of the person’s knowledge and reasoning ability to the situation. Sometimes a person *recognized* that contradiction, in a single step, a small-scale “leap of insight.” In other cases, the contradiction was *reasoned out*, in a brief series of steps. Perkins concluded that the insight process did not carry out a large amount of thinking, and that it was essentially equivalent to a few steps of reasoning. That conclusion raised problems for the Gestalt idea that insight was a special process, resulting in a far-ranging leap into the unknown, independent of such processes as knowledge and reasoning.

A second challenge to Gestalt theory came from a study by Weisberg and Alba (1981), which examined performance on the 9-Dot problem. The person is shown a 3×3 matrix of dots, and is asked to connect all the dots, using four connected straight lines; that is, without lifting the pencil from the paper. According to the Gestalt view, the problem was, in principle, not very difficult, since we can all draw four connected lines. However, the problem is, in fact, extremely challenging, with almost no one able to solve it. In the Gestalt view, the problem’s difficulty arose from the perceptual configuration of the problem: people were fixated on the square shape of the matrix, and kept their lines within the boundaries of the square. That restriction, not stated in the problem, but assumed by the participants, made the problem impossible to solve. According to the Gestalt analysis, if that restriction could be eliminated, the problem should become easy.

Weisberg and Alba tested that prediction, and those results also did not support the Gestalt view. Participants were told that, in order to solve the problem, they had to draw lines outside the boundaries of the square. That instruction resulted in people going “outside of the box,” but only a small minority of them solved the problem; and those who did, worked incrementally toward solution, rather than having things suddenly fall into place, as the notions of spontaneous restructuring and insight would lead one to expect. Weisberg and Alba concluded that the 9-Dot problem was difficult because it demanded sophisticated knowledge, which most people did not possess. They also argued that the notion of insight might not be useful in explaining how solution came about, at least in the context of the 9-Dot problem.

That pessimistic view on insight was extended by MacGregor, Ormerod, and Chronicle (2001), who proposed that the difficulties in solving the 9-Dot problem were the result of heuristics adopted by the problem solver. The problem is unsolvable because most people are unable to anticipate or imagine the negative outcomes of drawing all the possible series of lines that stay within the square shape, so they continue doing so. Their capacity for “lookahead,” related to visual working-memory (WM) capacity, is too small. It has been demonstrated that WM capacity may play a role in solution of the 9-Dot problem, which supports the perspective of Chronicle and colleagues.

Based on those experimental results, and their interpretations, a distinction was made, between insight as a *special process*—the Gestalt view; insight as the result of spontaneous restructuring—and insight as *business as usual*—insight as the result of analytic or reproductive thinking. Both Perkins and Weisberg and Alba can be seen as advocating the *business-as-usual* view. Presentation of the *business-as-usual* view stimulated several different types of responses from researchers supportive of the Gestalt view. First, research was carried out to demonstrate that there were explicit differences between the processes underlying productive thinking that results in insight, and those underlying reproductive or analytic thinking. That is, attempts were made to demonstrate the *special-process* nature of insight. Second, theorists attempted to make explicit the differences between Gestalt theory and the *business-as-usual* interpretation of insight. The classical Gestalt view was reformulated, into what one can call *neo-Gestalt* theory.

Responses to the Challenges to Gestalt Theory: Research Supporting the Special-Process View

A number of different types of evidence have been brought forth in support of the Gestalt view (for review, see Weisberg, 2020). In a seminal set of studies, Metcalfe presented evidence to support the notion of two modes of solving problems, insight versus analysis. Her studies were designed to show that insightful solutions of problems, arising, presumably, from a sudden restructuring of the problem situation, were brought about differently than solutions based on analysis. Those latter solutions presumably came about as the result of the application of one’s knowledge to a problem, and the use of that knowledge to gradually work out a solution. Metcalfe had people provide ratings of how *warm* they were—how close to the solution they felt they were—as they worked on insight versus analytic problems. Warmth ratings for solutions to analytic problems increased gradually, but warmth ratings for solutions based on insight stayed at a low level until just before the problem was solved, when they quickly moved to the maximum. Those results were taken as evidence that insight was the result of a sudden change in how the problem was perceived—a restructuring of the problem—which supported the Gestalt *special process* view.

Another demonstration of the difference between analysis and insight as modes of thinking was produced by Schooler, Ohlsson, and Brooks. They had individuals think aloud while trying to solve analytic versus insight problems, and they found that verbalization interfered with solution of insight problems, but not analytic problems. The results were taken as evidence that insight was brought about by processes that are not verbalizable, i.e., outside the domain of conscious analytic thought. Similarly, Gilhooly and Murphy (2005) gave individuals a group of analytic and insight problems to solve. Insight problems and analytic problems

each tended to be solved together, which was taken as evidence that different processes played a role in solution of the two types of problems. Further evidence in support of the analysis-insight distinction was the finding that solutions accompanied by an Aha! experience are more likely to be correct than are answers not accompanied by an Aha! It was proposed that solutions arising from insight bring with them subjective elements, including perhaps a feeling of confidence, as well as feelings of closure and pleasure, which might lead the individual to the belief that the solution must be correct, before verifying it and before feedback is given.

Going beyond traditional methods of studying problem solving, Kounios and Beeman (2015) and their colleagues have used neuroscience methods to demonstrate differences in the processes underlying insightful versus analytic solutions to problems. They examined performance on compound remote associates (CRA) problems, in which three words are presented, and the individual is asked to find a fourth word that will combine with each of the other words in a compound word or phrase. Here is an example problem.

Given these three words: *work, wise, tower*, find a fourth word that will combine with each of those words, to make a compound word or familiar phrase.

The answer is *clock*: clockwork, clockwise, clock tower. An important aspect of CRA problems is that people report solving them in two ways: incrementally, or in a burst of insight. That result means that the same type of problem can provide information concerning the brain processes underlying analytic thinking versus insight. Kounios and Beeman reported several differences in brain processes underlying solutions through insight versus analysis, and concluded that there are significant differences between those processes. In addition, they reported that certain patterns of brain activity can predict if a person will solve a not-yet-presented problem with insight.

Still another attempt to demonstrate the difference between insight and analytic thinking is seen in the work of Wiley and her colleagues (e.g., Wiley and Jarosz, 2012), who proposed that insight differs from analysis in terms of the involvement of working-memory (WM). Analytic thinking, which depends on application of knowledge to a problem, and planning out the solution, would seem to put demands on WM. Insight, in contrast, comes about as a break from planning and analytic thinking, and so would seem to be independent of WM. Wiley and colleagues presented evidence for the lesser involvement of WM in solution of insight problems.

The research just reviewed is a sample of the sorts of studies carried out by supporters of the Gestalt view. Those various research projects were accompanied by attempts to expand classical Gestalt theory, to deal with the challenges raised by researchers critical of the insight view. Attempts were made to make the theory more amenable to empirical test, as well as to make more specific the differences between the role of insight versus analysis in thinking.

Neo-Gestalt Theory

Ohlsson's Representational Change Theory

In emphasizing the *special-process* aspect of insight, Ohlsson (2011) pointed to the importance of restructuring and insight as nothing less than a factor in our survival as a species. The world is in a state of unpredictable, large-scale, flux. Therefore, "experience is guaranteed to be misleading most of the time" (Ohlsson, 2011, p. 21). Ohlsson proposed that the mechanisms of *deep learning* have evolved to deal with that quandary. Deep learning makes it possible for us to:

abandon, override, reject, retract or suppress knowledge that we had previously accepted as valid in order to track a constantly shifting and fundamentally unpredictable environment and thereby indirectly create mental space for alternative or even contradictory concepts, beliefs, ideas and strategies. (p. 21)

One mechanism of deep learning is problem solving through insight, achieved through the already-familiar *insight sequence*. Ohlsson's theory is called *Representational Change Theory* (RCT), because the critical component in insight is restructuring the situation, that is, changing the representation of the environment.

RCT has undergone several iterations. Ohlsson (1992) originally proposed a set of three "switch when stuck" heuristics to account for the occurrence of insight. One is trying to *switch* the problem representation, because one is *stuck*. The restructuring heuristics were the following.

- (1) *Elaboration*: the individual examines the situation to determine if there is overlooked information or object(s) that could be used in a new type of solution.
- (2) *Re-encoding*: the individual analyses the situation, in order to determine if there is a new way of thinking about any object.
- (3) *Constraint relaxation*: the individual attempts to change the representation of the goal.

The second version of RCT, Ohlsson (2011, ch. 4, 11) proposed that representational change came about as the result of *redistribution of activation* in semantic memory. Ohlsson assumed that any problem will activate representations of differing strengths, based on experiences in similar situations. The strongest of those representations will control the behaviors that are produced.

In situations that demand creative thinking, that initial representation, based on the past, will result in failure. Each time a solution results in failure, it produces negative feedback for the representation. If those failures continue, in an impasse, the initially-dominant representation will be replaced by one of the other possible representations. The person will then look at the problem differently, in a restructuring, which may result in a new class of solutions. That analysis of restructuring in problem solving is similar to the Gestalt psychologists' notion of the "spontaneous" reversal of a reversible figure. Restructuring comes about as the result of processes not under the conscious control of the person.

In the newest version of RCT (Ohlsson, 2018), representational change can occur without failure and impasse. If information from the environment does not match expectations, it may force a change in the analysis of the situation. Since experience cannot be helpful at that point, Ohlsson proposed that semantic analysis of the problem can result in a new structure.

Other Neo-Gestalt Views

Other researchers have developed neo-Gestalt views, which build on classic Gestalt theory, and are similar to Ohlsson's RCT. Perkins (2000) proposed the need for *breakthrough thinking* in problem solving, because many problems do not yield to analytic thinking, which is based on reason. Those problems are *unreasonable*, and demand that one break away from analytic—"reasonable"—thinking, and search in other ways for new ideas. A similar view was presented by Wiley and her colleagues (e.g., Ash et al., 2009; Danek et al., 2018; Wiley and Jarosz, 2012), who made a categorical distinction between analysis and insight. Similar to other neo-Gestalt views, Wiley and colleagues argued that the critical shortcoming of analytic thinking is that there are problem situations in which it is not useful. In order to progress, the thinker must reject analytic thinking, and re-structure the situation: "[R]estructuring is a mechanism that cannot be accommodated by classic heuristic search accounts of problem solving, and requires an additional theoretical framework" (Ash et al., 2009, p. 8).

Thus, theories of problem solving must include a mechanism—restructuring, a special process—that goes beyond analytic thinking. A similar viewpoint was proposed by Kounios and Beeman and their colleagues (e.g., 2015), who also emphasized the close relationship between creative thinking, restructuring, and insight.

Insight and Creativity in Neo-Gestalt Theory

Insight and creativity are closely linked in the neo-Gestalt views. According to Ohlsson (2011) and Perkins (2000), if an advance does not come about through insight, it is not creative. Similarly, Wiley and Jarosz (2012) dichotomized analytical problems (such as verbal mathematics problems) and "creative" problems, that is, problems that must be solved through insight. Wiley and Jarosz do not consider the possibility that insight ("creative") problems could be solved through analytic thinking. However, recent research has found that analytic thinking can bring about solutions to insight problems.

Analytic Thinking in Solving "Insight" Problems

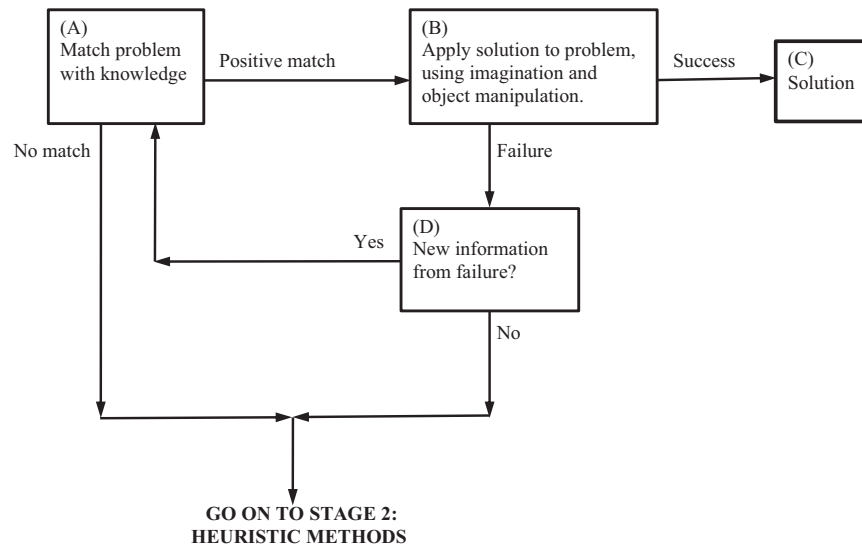
Fleck and Weisberg (2013) examined people's performance on several insight problems, and found that analytic thinking brought about solutions to "insight" problems, including solutions based on restructuring. Fewer than 10% of the solutions were the result of the full insight sequence. Those results raised questions about whether insight and analysis are different processes. Most of the solutions in Fleck and Weisberg's study were based on heuristic methods, of several sorts. That finding contradicts the proposal just quoted, that restructuring in problem solving cannot come about through heuristic methods.

An Integrated Model of Insight

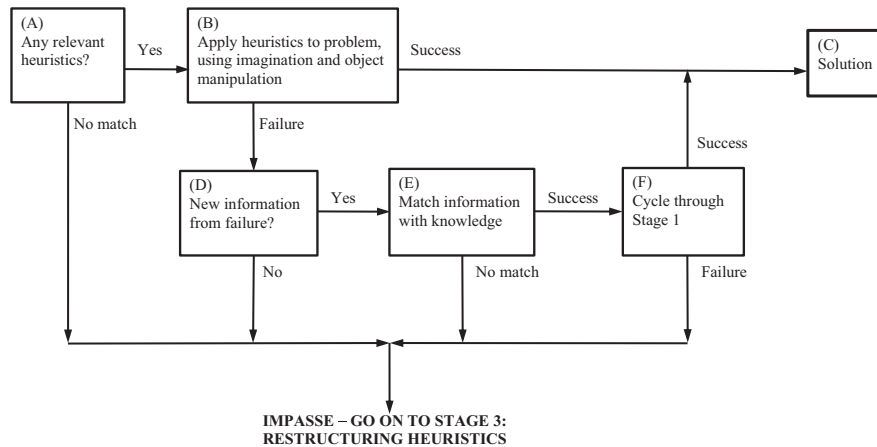
In response to their results, Fleck and Weisberg (2013) proposed a model of problem solving that incorporated analysis *and* insight as components. That model attempted to provide an integrated view of a wide range of results from problem-solving research. The model, presented in Fig. 1, assumes that the first stage in problem solving, as in all cognitive processes, involves an attempt to match the problem with information in memory. If there is information in memory that is relevant to this particular problem (Stage 1A—Positive match), then a possible solution will be brought to mind, and the person will attempt to transfer that old solution to the current problem. If that transfer is successful (Stage 1B—Success), the problem is solved (Stage 1C). If transfer fails, but new information arises out of that failure (Stage 1D), then the person searches memory again, with the possibility that a new method will come to mind (recycling through Stage 1A). Critically for the present discussion, restructuring of the problem may occur at this point in the process; new information that has arisen from failure may bring to mind a new way of analyzing the problem. This restructuring can be called "top-down" restructuring: it uses the person's knowledge to deal with any shortcomings in the failed solution.

If a method tried at Stage 1 fails, and no additional information arises from that failure, the person goes to Stage 2, and attempts to apply heuristic methods to the problem. Examples of heuristic methods would be logical analysis of the information in the problem; attempting to apply mathematical methods to the problems; using means-ends analysis or hill-climbing; or trial-and-error. If one of those methods works, the problem is solved (Stage 2C). If new information arises out of a failure of a heuristic method (Stages 2B and 2D), that can produce another "top-down" restructuring, and another search of memory (Stage 2E).

STAGE 1 – MATCHING A PROBLEM WITH KNOWLEDGE



STAGE 2 – APPLYING HEURISTICS TO A PROBLEM



STAGE 3 – RESTRUCTURING HEURISTICS IN RESPONSE TO IMPASSE (BOTTOM-UP RESTRUCTURING)

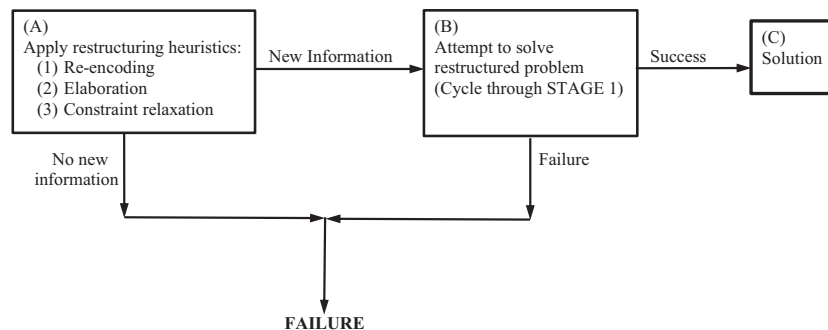


Figure 1 Problem solving model (Stages 1–3).

That search can result in a new solution method being retrieved (Stage 2F). This would be another example of restructuring arising from a failed solution attempt.

An important point to take away from the discussion of analytic thinking in stages 1 and 2 of the model in **Fig. 1** is that analytic thinking is an *active* process. The individual is constantly receiving new information, in feedback from the environment, which can significantly change the situation, and produce responses that are totally different from where the person might have begun.

If there is no solution, and no new information from Stage 2, then the person is at an impasse, and goes on to Stage 3, where the restructuring that is the focus of the neo-Gestalt theorists may come about. [Ohlsson's \(1992\)](#) three restructuring heuristics—*elaboration*, *re-encoding*, and *constraint relaxation*—are incorporated in Stage 3. Several of [Fleck and Weisberg's \(2013\)](#) participants went through those heuristics upon reaching impasse, so there is empirical support for their inclusion in models of insight. Those restructuring heuristics can produce result in “bottom-up” restructuring: it comes about through an examination of the objects in the problem, without any overarching plan as to how the problem might be re-structured. That sort of processing would be expected if a person is at impasse.

In sum, the model outlined in [Fig. 1](#) provides a framework that can serve as the basis for integrating analysis and insight into an overarching scheme for understanding problem solving. However, the study of insight is at present an area in which much research activity is taking place. Therefore, it is premature to conclude that anything like closure has come about in this area. This discussion will conclude with an examination of a number of issues that are the subject of debate.

Insight: Some Remaining Questions

How Important Is Insight in Creative Thinking?

Researchers' interest in insight is based on the assumption that insight is critical in our dealings with the world. However, until relatively recently, that assumption has not been explicitly tested. [Beatty et al. \(2014\)](#) examined directly the relationship between insight and creativity. In two studies, with large samples of undergraduates as participants, they found no relationship between solving insight problems in the laboratory and real-world creative achievement. Undergraduates, because of their limited opportunities, might not be the best population in which to study creative achievement; however, the results still raise questions for the idea that insight is the core of creative thinking.

On Executive Functioning in Insight

[Wiley and Jarosz \(2012\)](#) and their colleagues proposed, based on neo-Gestalt theory, that a high level of executive functioning has negative effects on insight. Research by [Chuderski and Jastrzebski \(2018\)](#) demonstrated that executive functioning was important in insight, which contradicted the neo-Gestalt view, and provided support for the analytic view. A large number of participants were given a set of insight problems to solve; as well as tasks testing logical reasoning and aspects of working memory, as measures of executive functioning. Insight performance was very closely related to measures of executive functioning, indicating that the two constructs might be closely related, or even identical. Other research has supported the conclusion of Chuderski and Jastrzebski.

Thus, research concerning the possible role of executive functioning in insight produced conflicting results. Some studies showed that executive functioning has a positive relationship with problem solving through insight. Other research supported the opposite view, that executive functioning is negatively related to insight, or not related at all. DeCaro and her colleagues (e.g., [DeCaro, 2018](#)) proposed that the role of executive functioning in problem solving depends on the specific details of the problem being worked on. If a problem is complex, making it difficult to understand the instructions and, therefore, to create the problem representation, then high levels of executive functioning should be helpful. If a problem is not complex, then all individuals, irrespective of level of executive functioning, should be able to formulate the initial representation.

DeCaro and others assumed that, once an impasse has been reached while trying to solve a problem, restructuring and insight come about through processes that are independent of executive functioning. In contrast, the integrated model of problem solving discussed earlier leads to the expectation that executive functioning would be important in insight. The *switch when stuck* heuristics, that play a role in stage 3 of the model, would seem to require executive processes, first to develop solution methods for a given problem, and then to carry them out. There are still some questions to be resolved concerning the role of executive functioning in insight.

The Aha! Experience as the Defining Characteristic of Insight

The Gestalt psychologists argued that the critical role in insight is restructuring the problem representation (e.g., [Scheerer, 1963](#)). There has been a movement recently toward an emphasis on the *Aha!* experience itself, rather than restructuring, as the defining feature of insight. [Bowden and Grunewald \(2018\)](#), for example, proposed that, to study insight, researchers should concentrate on situations where an *Aha!* occurs. However, using *Aha!* experiences to define insight might lead to problems for researchers, because one can have an *Aha!* experience in situations having nothing to do with creative thinking. As one example, the experience that can accompany the sudden recall of a previously irretrievable name—resolution of a “tip-of-the-tongue state”—may be indistinguishable from the *Aha!* that accompanies sudden solution of a problem. If so, defining insight in problem solving may require more than determining the presence versus absence of the *Aha!* experience. Here is another area where more research is called for.

Insight versus Analysis: Different Philosophies Concerning Creativity

Neo-Gestalt theory takes a two-pronged perspective on creativity. It is assumed that individuals are capable of productive thinking. However, people often fail to think productively, because of factors that conspire against it. Those factors include the large-scale changes in the world, that make it resistant to transfer of knowledge; as well as smaller-scale aspects of problems, that work against using productive thinking to deal with them. The analytic viewpoint, in contrast, assumes that the world is typically receptive to the transfer of knowledge. If that were not true, it would be hard to understand why organisms have developed the capacity to remember the past.

In discussing analogical transfer, Gentner proposed the “kind world” hypothesis, which assumed that things in the world are often what they appear to be (Gentner and Maravilla, 2018). That is, if something looks very much like a tiger, it may very well be a tiger. Therefore, applying one’s knowledge to the world is, in most cases, a useful way of dealing with issues that arise in our interactions with the environment. Attempting to use the past as the first step in dealing with the present, combined with the active nature of analytic thinking (see Fig. 1), can sometimes be the basis of creative advances.

Those differing philosophies motivated different sorts of approaches to the study of problem solving and creativity, which have resulted in disagreements over interpretation of research results. In addition, research in recent years have resulted in large-scale differences in theoretical analyses brought forth to place specific research results into a broader context. The last few decades have brought an acceleration of research in the study of insight, broadly construed, and there are no signs of a lessening of interest in this area. The future promises to bring increases in understanding of this central aspect of human cognition.

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Further Reading

Vallee-Tourangeau, F. (Ed.), 2018. *Insight: On the Origins of New Ideas*. Routledge, London. The chapters in this edited volume provide an up-to-date sampling of current views on insight.

Inspiration

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Introduction

In his novel *Doctor Zhivago*, Boris Pasternak described an episode of inspiration:

After two or three stanzas and several images by which he was himself astonished, his work took possession of him and he experienced the approach of what is usually called inspiration. At such moments the correlation of forces controlling the artist is, as it were stood on its head. The ascendancy is no longer with the artist or the state of mind which he is trying to express, but with language, his instrument of expression. (1961, p. 427)

This passage captures the hallmark features of inspiration: passive evocation (“his work took possession of him”), transcendence (“the ascendancy”), and an impulse toward expression (“language, his instrument of expression”). Echoing other creators before him (Clark, 1997), Pasternak’s account poses a perennial but controversial thesis: inspiration is a central force in the creative process.

Traditionally, scholars portrayed inspiration as a mystical phenomenon outside the scope of science. In ancient Greece, Plato described poetic inspiration as divine madness, a possession by the Muse that imbues the poet with a vision of beauty and truth. By the 17th century, inspiration was predominantly discussed in the context of religion, where the Bible was professed to be the gateway to divine revelation (Lowth, 1971). In the 18th century, the focus shifted to unconscious sources of inspiration that are within the person but external to the conscious self. Scholars no longer defined inspiration as an external source of power, but rather a natural energy of the mind (e.g., enthusiasm and passion) that exists in a person’s own being (Ponsford, 1986).

Contemporary psychologists often invoke the inspiration concept, yet tend to do so informally without defining the term. Therefore, usages vary considerably. Some creativity researchers equate inspiration with creativity. Others use inspiration as a synonym of insight or illumination. Some psychologists continue to portray inspiration as a supernatural phenomenon and hence describe it as unscientific and irrelevant to the science of creativity.

Further complicating matters, some scientists have challenged the importance of inspiration without defining the term clearly. For example, Martindale (2001) endorsed Thomas Edison’s claim that genius is 1% inspiration and 99% perspiration and suggested

that no scientist disputes Edison's claim. What exactly is it that all scientists are purported to believe? That perspiration is important, or that inspiration is unimportant, or both? And what do these terms mean exactly?

It would be imprudent to dismiss the inspiration concept given longstanding interest in the humanities and the nascent state of the scientific literature on the subject. In an effort to investigate inspiration in earnest, Thrash and Elliot (2003) proposed a general conceptualization of inspiration by integrating usages from diverse disciplines. The next section discusses this domain-general conceptualization and subsequent conceptual developments.

Inspiration as a General Construct

Conceptualization

Core Characteristics

The *tripartite conceptualization* identifies three core characteristics that define the state of inspiration: evocation, transcendence, and approach motivation (Thrash and Elliot, 2003). *Evocation* refers to the passive or receptive manner by which inspiration is elicited; one does not feel volitionally responsible for becoming inspired, at least not directly, because inspiration is a response to a stimulating influence. *Transcendence* refers to an epistemic change in which one gains awareness of new and better possibilities. This change often, but not always, occurs during a sudden moment of illumination or insight. *Approach motivation* refers to the motivational impetus to bring one's new vision into fruition. These three core characteristics are necessary and collectively sufficient to distinguish inspiration from other constructs (Thrash et al., 2014). For instance, awe shares with inspiration the qualities of evocation and transcendence but does not involve arousal of approach motivation.

Component Processes

Whereas the tripartite conceptualization identifies the characteristics of inspiration, the more recent component process conceptualization identifies its parts: being inspired *by* and being inspired *to* (Thrash and Elliot, 2004). Being inspired *by* occurs when one is moved by the perceived intrinsic value in an evocative object (e.g., a piece of art, a role model, or a creative idea). Being inspired *to* occurs when one becomes motivated to extend, transmit, or actualize the perceived intrinsic value found in the evocative object. This component process conceptualization is consistent with and complements the tripartite conceptualization. Being inspired *by* gives rise to the characteristics of evocation and transcendence; being inspired *to* corresponds to approach motivation.

Consider some implications of the component process conceptualization. First, evocation and transcendence characterize the same component process and may be viewed as two sides of the same coin. Transcendence requires evocation. Generally, one cannot transcend one's epistemic limits through an act of will; one must be awoken. Second, gaining awareness of better possibilities and ensuing motivation are distinct processes and therefore do not always co-occur. For example, a painter enamored of the grace of mother nature (inspired *by*) may or may not feel compelled to capture the scene on canvas (inspired *to*). Similarly, a spontaneous insight may or may not lead to inspired action. By definition, inspiration is considered present when both the *by* and *to* component processes are activated.

Transmission Model

Most recently, scientists have rounded out the conceptualization of inspiration by theorizing about the function it serves. Inspiration is theorized to motivate the transmission of perceived intrinsic value, such that intrinsic value is transmitted from an elicitor object to an outcome object (Thrash et al., 2010). From a statistical modeling standpoint, inspiration may be viewed as a mediating (intervening) process. Encounter with a source of intrinsic value evokes inspiration, which in turn energizes transmission of the intrinsic value.

Transmission may take any of three forms: replication, actualization, or expression (Thrash et al., 2014). *Replication* occurs when one reproduces the intrinsically valuable features of an existing elicitor object in a new object. *Actualization* occurs when one brings newly imagined possibilities into fruition. *Expression* occurs when ideas flow out swiftly, having arrived well-formed in the same sensorimotor modality in which they are to be expressed. Regardless of which form it takes, inspiration is qualitatively different from most other human motivations. Most are *telic*, or goal focused, whereas inspired transmission is *mimetic*—i.e., imitative, preservative, or expressive (Thrash, in press).

Contrary to the conventional wisdom that inspiration is a purported source or cause of creative ideas, the transmission model clarifies that inspiration is a response to creative ideas; inspiration motivates the process of bringing ideas into fruition. Thrash et al. (2010) have confirmed this empirically. There are two benefits of the proposed model. First, the specified sequence is consistent with scholarship in the humanities, where the concept of inspiration originated. For instance, theologians distinguish inspiration (the human act of articulating divine wisdom) from revelation (God's act of revealing divine wisdom to the human mind). Second, suggesting that inspiration explains the origins of creative ideas would not aid scientific understanding. We are better off ascribing the origins of creativity to the kinds of cognitive, biological, social, and cultural processes that creativity researchers already study. The motivation triggered by creative insight is a topic that creativity researchers have neglected, and inspiration fills this gap perfectly.

Operationalization and Validation

Formally, inspiration is an episode that unfolds across time (Thrash et al., 2014). Such episodes give rise to state and trait variance. At the state level, one may think of inspiration as being more or less present for a particular person at a particular moment. At the trait level, one may think of some people as more prone than others to experiencing episodes and states of inspiration.

General Trait Inspiration

Thrash and Elliot (2003) developed the Inspiration Scale (IS) to assess inspiration at the trait level. The eight-item questionnaire consists of two four-item subscales that assess the frequency and intensity of inspiration. Inspiration frequency and intensity are strongly correlated ($r = 0.60\text{--}0.80$), and therefore a combined score is useful as an overall index of trait inspiration. The IS has excellent psychometric properties. It has the expected two-factor (frequency, intensity) structure, is internally consistent (Cronbach's $\alpha \geq 0.90$), has strong test-retest reliability ($r = 0.77$), and has invariant measurement properties across time and across populations.

Thrash and Elliot (2003) found that trait inspiration relates meaningfully to variables from major theories of personality and motivation. Of the Big 5 personality traits (extraversion, neuroticism, agreeableness, conscientiousness, openness to experience), inspiration correlates positively with openness and extraversion. These traits correspond theoretically with the component processes of being inspired *by* and being inspired *to*, respectively. Regarding motivation correlates, inspiration converges with indicators of approach motivation, intrinsic motivation, and work-mastery motivation. The relation with approach motivation is consistent with the tripartite conceptualization; inspired individuals are motivated to bring new and better ideas into fruition. The relation with intrinsic motivation suggests that inspired activity is inherently enjoyable and fulfilling. Finally, the relation with work-mastery motivation implies compatibility between inspiration and “perspiration.” Inspired individuals are more likely, not less likely, to work hard to achieve task mastery and develop their skills. Other correlates of inspiration include perceived competence, optimism, self-esteem, nostalgia proneness, positive affect, and progress toward personal goals (Milyavskaya et al., 2012; Thrash and Elliot, 2003; Stephan et al., 2015).

General State Inspiration

To validate inspiration at the state level, Thrash and Elliot (2004) compared self-narrated inspiration experiences to narratives of ordinary daily experiences (as a control condition). Inspiration narratives showed evidence of evocation (e.g., passive self, low volitional control), transcendence (e.g., meaning, spirituality), and approach motivation (e.g., activated positive affect; hereafter called positive affect). Thus, the inspiration narratives provided evidence of all three core characteristics of inspiration, supporting the tripartite conceptualization at the state level of analysis. In addition, supporting the component process conceptualization, a confirmatory analysis demonstrated that being inspired *by* and being inspired *to* are distinct and converge meaningfully with indicators of transcendence, evocation, and approach motivation (Thrash and Elliot, 2004).

Inspiration was also found to differ meaningfully from its strongest known correlate, positive affect, a basic dimension of mood that involves feeling excited and alert (Thrash and Elliot, 2004). The two states involve similar levels of approach motivation, but inspiration involves higher levels of transcendence and evocation. Additionally, inspiration and positive affect were found to have different antecedents. Inspiration was predicted proximally by illumination and distally by openness-related traits. In contrast, positive affect was predicted proximally by reward salience (i.e., the opportunity to get something desired) and distally by approach temperament. These findings suggest that inspiration and positive affect serve different functions—transmission and acquisition, respectively.

Inspiration and positive affect have also been found to occur on different days of the week. Whereas positive affect is roughly equally distributed across days of the week, inspiration is more likely to occur on weekdays than weekends (Thrash, 2007). It appears that the TGIF (“thank goodness it’s Friday”) attitude is not conducive to visitation by the muse.

Inspiration in the Creativity Domain

Conceptualization of Inspiration Within the Domain of Creative Activity

Traditionally, as noted, the creativity research literature has not provided a clear definition of inspiration. The solution proposed by Thrash et al. (2010) was to apply the general inspiration construct, based on the interdisciplinary literature review and construct validation research discussed above, to the specific domain of creative activity. From the perspective of the tripartite conceptualization, the general quality of transcendence may be replaced by illumination or insight into a creative solution. From the perspective of the component process conceptualization, inspiration involves being inspired by a creative possibility specifically rather than intrinsic value generally. From the perspective of the transmission model, the function of inspiration may be understood as transmission of a creative idea. That is, inspiration is a response to a creative idea, and it motivates the translation of the creative idea into a creative product.

In light of this model, perhaps it is not surprising that there has been so much confusion about how inspiration relates to creativity. Inspiration is an effect of creativity *in an idea* and a cause of creativity *in a product*. This conceptualization removes any hint of unscientific supernatural influence, while preserving the mimetic spirit of inspired transmission as it has been described for millennia (Clark, 1997).

Because the concept of transmission may seem a bit abstract, the remainder of this section provides examples of the three forms of transmission as they occur in the context of creative activity. The *replication* form of transmission occurs when one perceives intrinsic value in a preexisting object that calls for re-expression in the form of a creative product. The English writer Virginia Woolf described an experience in which an encounter with the world awakened a creative impulse that can be categorized as replication:

Boats float past, through the red, through the green ... Oh I am in love with life ... Now begins to rise in me the familiar rhythm; words that have lain dormant now lift, now toss their crests, and fall and rise and fall and rise again. I am a poet yes. Surely I am a great poet. (Haule and Smith, 1993, p. 51)

Actualization involves bringing a creative insight or feeling into fruition. An example of actualization comes from Romantic poet Percy Bysshe Shelley (1840):

The mind in creation is as a fading coal, which some invisible influence, like an inconstant wind, awakens to transitory brightness; this power arises from within ... could this influence be durable in its original purity and force, it is impossible to predict the greatness of the result; but when composition begins, inspiration is already on the decline; and the most glorious poetry that has been communicated to the world is probably a feeble shadow of the original conceptions of the poet.

Expression involves channeling content that flows out spontaneously in the same sensorimotor modality in which it arises. An example of expression comes from the English poet, Stephen Spender (Chiselin, 1975, p. 118): "My own experience of inspiration is certainly that of a line or a phrase or a word or sometimes something still vague, a dim cloud of an idea which I feel must be condensed into a shower of words."

Further Validation Specific to the Domain of Creative Activity

Having introduced the general inspiration construct to the creativity literature, Thrash et al. (2010) supplemented the original construct validation research with a test of the tripartite conceptualization within the context of creative writing. A questionnaire about the writing process included two items related to evocation (e.g., "these ideas came to me unexpectedly or spontaneously"), transcendence (e.g., "I saw some deep truth when I wrote this"), approach motivation (e.g., "these ideas energized and motivated me"), and overall inspiration (e.g., "I felt inspired while writing this"). Two additional items assessed effort (e.g., "I worked hard in writing this"). A principal components analysis yielded two factors, inspiration and effort. All eight inspiration items converged as indicators of the inspiration factor, and the two effort items converged as indicators of the effort factor. These findings support the tripartite conceptualization and establish discriminant validity (Thrash and Elliot, 2003).

Empirical Evidence of a Relation Between Inspiration and Creativity

A series of studies documented a positive relation between inspiration and creativity (Thrash and Elliot, 2003). In one study, individuals who were more prone to inspiration were found to describe themselves as more creative. In another study, individuals were found to feel more creative on days when they are more inspired. In a third study, US patent holders who experience inspiration more frequently were found to hold more patents. Receipt of patents is an objective and culturally significant indicator of creativity.

Another set of studies focused on inspiration in the writing process. Across three types of writing (scientific writing, poetry, fiction), inspiration while writing was found to predict the creativity of the product, as evaluated by expert coders (Thrash et al., 2010). These findings were robust when a variety of covariates (e.g., effort) were controlled. An and Youn (2018) reported that inspiration predicted a variety of indicators of creativity, including performance on a test of remote associates, as well as originality and fluency on alternate uses tasks. Ngara (2010) documented the importance of inspiration to Shona stone sculptors in Zimbabwe.

Evidence of Transmission

Thrash et al. (2010) conducted a longitudinal study and found that creative ideation tends to precede feelings of inspiration, consistent with the transmission model. In the poetry and fiction writing studies, they also conducted direct tests of the transmission model. In both studies, the creativity of a writer's initial idea (as appraised by the writer) predicted the creativity of the resulting text (as evaluated by expert judges). This effect was mediated by inspiration (as reported by the writer). Other positive affective-motivational states, such as effort, awe, and positive affect, were found not to function as mediators of transmission, suggesting that the transmission function is unique to inspiration.

In the fiction writing study, the researchers also examined how personality influences the transmission process. The trait of openness to aesthetics was found to predict the creativity of the initial idea; approach temperament, in contrast, amplified the effect of

idea creativity on inspiration. Consistent with the component process conceptualization, which posits separate *by* and *to* components, inspiration requires an openness to ideas, as well as a motivational sensitivity to creative ideas as positive incentives. [An and Youn \(2018\)](#) recently reported that inspiration mediates between openness to aesthetics and creativity, as well as between art exposure and creativity.

Other Correlates of Inspiration in the Writing Process

In the poetry writing study, participants who were more inspired reported that their ideas came to them more fully formed. Their ideas were experienced as arising from unconscious or spiritual sources rather than from the conscious mind, and their ideas were experienced as emerging more suddenly and automatically. These quantitative findings are consistent with qualitative autobiographical accounts throughout history.

In their study of fiction writing, [Thrash et al. \(2010\)](#) used screen capture methods to assess objective writing behaviors and related them to the subjective experience of inspiration. Individuals who were more inspired wrote longer texts. This effect was attributable to the fact that inspired writers generated more words, as opposed to deleting fewer words. Inspiration was related to writing efficiency, such that inspired writers retained a greater proportion of the words that they typed. Inspired writers were also more productive in that they generated more retained words relative to how long they worked. Finally, inspired writers spent more of their time inscribing (adding or deleting words) and less of their time pausing. Another noteworthy finding was that writers who were more inspired tended to use shorter words. Together, these findings indicate that inspired writing is highly economical, consistent with the expressive function of inspiration.

Differentiation From Related Constructs

Inspiration is often confused with insight and is often treated as incompatible with “perspiration” or effort. The following sections clarify the relation of inspiration to insight and effort.

Inspiration Versus Insight

Inspiration is sometimes used synonymously with insight to refer to the emergence of creative ideas in consciousness ([Mayer, 1992](#)). Insight is a cognitive event, in which an idea enters awareness. Inspiration, in contrast, is a motivational state that is often triggered by insight. If insight always resulted in inspiration (i.e., motivation to actualize the insight), or if inspiration were always preceded by insight, perhaps there would be little reason to distinguish them. However, insights do not always lead to inspiration. Insight is more likely to lead to inspiration in individuals who have a stronger approach temperament ([Thrash and Elliot, 2004](#); [Thrash et al., 2010](#)). Moreover, inspiration can occur without insight, as when one is inspired by a relatively stable feature of the external environment (e.g., scenery near one’s home or the life of one’s mother). Therefore, insight and inspiration are distinct concepts, and these terms should not be used interchangeably.

Inspiration Versus Perspiration

It is time to retire the practice of pitting inspiration and effort against one another and advocating one over the other. Consider the following arguments.

First, inspiration and effort are positively related and compatible with one another rather than negatively related or mutually exclusive. For instance, individuals more prone to inspiration tend to be higher in work-mastery motivation, and inspiration and work-mastery motivation tend to peak on the same days ([Thrash and Elliot, 2003](#)). Moreover, both lead to higher levels of the other over time ([Thrash and Elliot, 2003](#)). Those individuals who are more inspired to write tend to exert more effort; and, when a given individual is more inspired than usual, he or she tends to exert more effort than usual ([Thrash et al., 2010](#)). Given that inspiration and effort tend to co-occur and reinforce each other, it does not make sense to claim that genius is 99% the latter and 1% the former.

Second, although inspiration and effort are compatible and co-occur to a degree, they are distinguishable constructs that uniquely predict different outcomes. Regarding writing quality, [Thrash et al. \(2010\)](#) found that inspiration predicts qualities that call for transmission or expression (e.g., creativity), whereas effort predicts qualities that call for volitional regulation (e.g., technical merit, use of rhyme). Inspiration and effort also relate to different objective aspects of the writing process. Whereas inspiration is related to the number of words generated, effort is related to the number of words deleted. Similarly, whereas writers who are inspired spend more time inscribing and less time pausing, writers who exert effort spend more time pausing (presumably to think or plan) and less time off task ([Thrash et al., 2014](#)). In short, inspiration and effort play different and complementary roles in the creative process.

Third, inspiration, like effort, is a motivational construct. Therefore, the fact that creativity requires motivation is not a reason to advocate effort over inspiration. In fact, [Thrash et al. \(2010\)](#) found that inspired individuals spent more time writing, whereas individuals who exerted more effort did not spend more time writing. Inspiration and effort both contribute in important ways to making the creative process happen.

Writer-Reader Inspiration Contagion

Plato argued that inspiration is infectious—the muse inspires the poet, the poet inspires the performer, and the performer inspires the audience. Researchers recently conducted the first scientific study of inspiration contagion from writers to readers (Thrash et al., 2017). The core hypothesis was that inspiration may be self-propagating, because the output of inspired transmission in a writer (e.g., an insightful text) may also function as input for inspired transmission in a reader. To test this hypothesis, the poems written in a prior study of inspiration in the writing process were given to a new sample of readers, who were asked to report on their inspiration in response to each poem. Readers also reported their personality traits. A panel of expert judges evaluated poem qualities.

Contagion and Mediation

Analyses indicated that writers who were more inspired wrote texts that were more inspiring to the average reader. This finding provides the first evidence of inspiration contagion. A mediation analysis documented two qualities of the text through which inspiration is passed from writer to reader: insightfulness and pleasantness. Writers who were more inspired generated texts that were more insightful and more pleasant; and insightful and pleasant texts were, in turn, more inspiring. Analyses also revealed one quality of inspired texts that undermined contagion to a degree: originality. Inspired writing was more original, and originality (as distinguished from insightfulness, etc.) tended to undermine reader inspiration.

Moderation by Reader Personality

In this same study, contagion of inspiration was found to be moderated by reader openness to experience. The effect of writer inspiration on reader inspiration was stronger among readers higher in openness. As in prior research, this finding highlights the fact that one needs to be sufficiently receptive to new and better ideas in order to become inspired.

Moderated Mediation

Why are readers higher in openness to experience more prone to inspiration contagion? Perhaps they are more responsive to the insightfulness of inspired writing, or more responsive to its pleasantness, or less uninspired by its originality? Moderated mediation analyses supported this last possibility. Readers high in openness were immune to the undermining of inspiration by originality, whereas readers low in openness were particularly prone to this undermining.

This finding seems to have external validity. Imagine the lineages of creators, innovators, and entrepreneurs who shape our culture. They must be comfortable contemplating new ideas in order to draw inspiration from one another. This finding is also consistent with Plato's suggestion that inspiration contagion occurs among poets, performers, and their audiences, who presumably are high in the trait of openness.

Related Findings

To provide additional evidence of the discriminant validity of inspiration and its covariates, researchers have also examined mechanisms underlying contagion of positive affect and awe (Thrash et al., 2017). Like inspiration, positive affect and awe were found to be infectious, but contagion occurred through somewhat different sets of mediators. Contagion of positive affect was mediated largely by the pleasantness of the text, and contagion of awe was mediated largely by sublimity. Together, these findings provide additional support for the discriminant validity of inspiration and its covariates. Writer effort was a relatively weak predictor of reader states.

Conclusion

Inspiration plays an important role in the creative process, as supported by the following arguments. First, inspiration is a motivational state that directly fuels the creative act. Second, inspiration makes creators more efficient and productive. Third, individuals who are more inspired produce works that are more creative, and a given individual is more creative when inspired. Finally, inspiration has far-reaching consequences. Inspiration is infectious because inspired works embody the spirit with which they were created. It is worth considering whether similar processes occur in other domains, including the contagion of inspiration through scripture and through online media.

Inspiration and effort are compatible and complementary. The opposite of effort is not inspiration; it is laziness. The opposite of inspiration is not effort; it is a lack of inspiration. The ideal is to have a capacity for both inspiration and effort. The former is the fuel that enlivens us as we translate creative ideas into creative solutions. The latter is a volitional resource that helps us power through the less appealing aspects of the creative process.

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Intelligence[☆]

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How are intelligence and creativity related? The question is important because, in our schools, we seem to value intelligence over creativity, but in life, creativity is at least as important because it involves adapting to the novel situations that can lead people either to great success or stunning failure. Not only is the relationship important for theoretical reasons, it also has tremendous applied value in the schools, workforce, and our everyday lives.

The roots of creativity as a scientific discipline are planted in the intelligence literature. Many of the earlier scholars (such as Francis Galton, Lewis Terman, Alfred Binet, and Charles Spearman) who considered and discussed creativity were more primarily focused on intelligence. Indeed, it was an intelligence researcher, [J.P. Guilford \(1950\)](#), who first publicly recognized the need for an independent study of creativity.

[Guilford \(1967\)](#) placed creativity into a larger framework of intelligence in his Structure of Intellect model. He attempted to organize all of human cognition along three dimensions. The first dimension was called ‘operations,’ and simply meant the mental processes needed to complete almost any kind of task, such as cognition. The second dimension, ‘content,’ referred to the general subject matter, such as words. The third dimension, ‘product,’ represented the actual products that might result from different kinds of thinking in different kinds of subject matters, such as writing. With five operations, four contents, and six products, Guilford’s model had 120 different possible mental abilities. Indeed, he later expanded the model to include 180 different abilities, although the 120 abilities model is the one more often studied.

One of Guilford’s operations (or thought processes) was divergent thinking – analyzing one’s response to questions with no obvious, singular answer. Such questions might include “What would happen if we didn’t need sleep?” This work, followed up by other researchers (most notably E. Paul Torrance), has often been used as a measure of creativity. Two of the most common ways of scoring these tests are fluency (the total number of responses given) and originality (how unique are the responses).

Theories of Intelligence Which Encompass Creativity

Guilford placed creativity within the context of an intellectual framework. In doing so, he was the first of many to consider creativity to be part of intelligence. Some theories of intelligence include creativity as a subcomponent. Undoubtedly, the theory of intelligence that is most often applied to IQ tests is the CHC (Cattell–Horn–Carroll) theory, a combination of two earlier theories ([McGrew, 2009](#)). The Cattell–Horn theory initially proposed two types of intelligence, crystallized (Gc) and fluid (Gf). Gc is what a person knows and has learned, whereas Gf is how a person handles a new and different situation (i.e., problem solving). Horn expanded the theory to include more dimensions (known as Broad Abilities). [Carroll’s \(1993\)](#) theory proposed a hierarchy of intellectual abilities. At the top of the hierarchy is general ability; in the middle of the hierarchy are various broad abilities (including learning and memory processes and the effortless production of many ideas). At the bottom of the hierarchy are many narrow, specific abilities such as spelling ability and reasoning speed.

The combined CHC theory incorporates both the concept of a general intelligence (all of the different aspects of intelligence are considered to be related to a common ‘g’, although this aspect is not often emphasized) and the concept of many different aspects of intelligence ([McGrew, 2009](#)). Ten different broad factors of intelligence are proposed. These include Gf and Gc from the initial

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Cattell–Horn theory. They also include Gq (quantitative knowledge, typically math-related), Grw (reading and writing), Gsm (short-term memory), Gv (visual processing), Ga (auditory processing), Glr (long-term storage and retrieval), Gs (processing speed), and Gt (decision speed/reaction time). Of these 10, only 7 are directly measured by today's intelligence tests: Gq and Grw are in the domain of academic achievement, and, therefore, are measured by achievement tests, and Gt is not measured by any major standardized test. Intelligence tests may indirectly measure some of these other skills, however. For example, intelligence tests indirectly measure achievements in various areas. The Stanford–Binet 5 and the Woodcock–Johnson–Revised were the first intelligence tests to be built on Gf–Gc theory. Today, nearly every major intelligence test is founded either explicitly or implicitly on the current version of the theory, namely, CHC.

Although in the early stages of the Cattell–Horn Gf–Gc theory, Gf (fluid intelligence) was hypothesized to be strongly linked to creativity, such a relationship is no longer explicitly part of the CHC theory. The current model, based on factor analytic studies by Carroll and others, includes originality/creativity as a component of long-term storage and retrieval (Glr). The most recent presentations of CHC theory argue that some Glr narrow abilities impact such creativity-relevant abilities as divergent production, ideational fluency, or associative fluency. In the detailed description of the model, connection is the only mention of creativity, originality, or divergent thinking. Fluid intelligence (Gf) is discussed in terms of its relationship to problem-solving and coping with novel problems (both considered to be highly related to creativity), yet the emphasis is on Glr. There has also recently been discussion of splitting Glr into Gl and Gr, with Gr including the creativity-related abilities mentioned above (Schneider and McGrew, 2019).

Others proposed a differential relationship between Gs (processing speed) and creativity. Creative people are selective with their speed of information processing. Early in the creative problem-solving stage, they widen their breadth of attention, allowing a larger amount of information to be processed (and thereby lowering their speediness). Later, when the problem is better understood, their attention span is shortened and their reaction time is quicker (Vartanian et al., 2007). This theory is reminiscent of Sternberg's distinction between global and local planning: According to Sternberg, brighter people spend more time in initial global planning so that later they do not have to spend as much time in local planning.

Some have argued that the current CHC model short-changes creativity. Placing all references to creativity and originality under Glr (or Gr) seems quite narrow. The ability to draw selectively on past experiences is essential for creating something new. But the connection between fluid intelligence and creativity is minimized in new conceptions of the model. A theory of intelligence that has recently been applied to school admissions is Sternberg's theory of successful intelligence. This theory comprises three 'subtheories': a *componential subtheory*, which relates intelligence to the internal world of the individual; an *experiential subtheory*, which relates intelligence to both the external and the internal worlds of the individual; and a *contextual subtheory*, which relates intelligence to the external world of the individual. The componential subtheory specifies the mental mechanisms responsible for planning, carrying out, and evaluating intelligent behavior. The experiential subtheory expands on this definition by focusing on those important behaviors that involves either adjustment to relative novelty, automatization of information processing, or both. The contextual subtheory defines intelligent behavior as involving purposeful adaptation to, selection of, and shaping of real-world environments relevant to one's life.

The experiential subtheory is directly related to creativity. Sternberg's application assessments of creativity to admissions data increased prediction of college success beyond that obtained with standard admissions tests; in addition, ethnic-group differences were significantly reduced. Gardner's (2011) well-known theory of multiple intelligences does not specifically address creativity. However, his eight intelligences (interpersonal, intrapersonal, spatial, naturalistic, linguistic, logical-mathematical, bodily-kinesthetic, and musical) certainly seem to apply to creativity. Gardner has used case studies of eminent creative individuals to argue that creative people can shine as a function of embodying different intelligences. For example, he selected Freud as an example of intrapersonal intelligence; Einstein to represent logical-mathematical intelligence; Picasso, spatial intelligence; Stravinsky, musical intelligence; T. S. Eliot, linguistic intelligence; Martha Graham, bodily-kinesthetic intelligence; and Gandhi, intrapersonal intelligence (naturalistic intelligence had not been added at this time).

Another theory of intelligence that incorporates creativity is Luria's (1966) neuropsychological model. Like the CHC model, Luria's model is frequently applied to intelligence tests. This model has three functional units; the first unit is responsible for focused and sustained attention. The second functional unit receives and stores information with both simultaneous and successive (or sequential) processing. Simultaneous processing involves integrating chunks of information together, largely in parallel; chunks are synthesized together simultaneously, much as one might appreciate a painting all at once. Successive processing is interpreting chunks of information separately, in sequential fashion, much as when one listens to a news broadcast reporting successive stories.

The third functional unit is responsible for planning, decision-making, and self-monitoring behavior. It is this last ability, planning, that has been hypothesized to be related to creativity. For example, studies have found that planning oriented cognitive styles were strongly linked to creative productivity. Also, people who spent time planning and replanning a project were more productive and more creative.

Theories of Creativity That Encompass Intelligence

Systems Theories

In recent years, there has been an emphasis on creativity theories that incorporate factors that are interrelated. Some of these theories emphasize issues such as the environment or evolution and are less relevant here. Other theories emphasize a confluence of different elements and include intellectual and cognitive abilities in the equation. One such theory is Sternberg and Lubart's (1995) 'investment' theory of creativity, in which the key to being creative is to buy low and sell high in the world of ideas. In

this model, a creative person is like a talented Wall Street investor. A successful creator will generate ideas that may be initially unpopular or underappreciated (as in buying stocks with low price-earnings ratios), yet will persist and convince others of the ideas' merits. The creator will then know when to move on to pursue other ideas (as in selling high, when one divests oneself of stocks).

According to this model, six main elements contribute to creativity: intelligence, knowledge, thinking styles, personality, motivation, and the environment. Intelligence contributes using three elements drawn from Sternberg's triarchic theory (later expanded into the theory of successful intelligence).

The first element is synthetic ability, which is the ability to generate ideas that are novel, high in quality, and high in task appropriateness. Because creativity is viewed as an interaction between a person, a task, and an environment, what is novel, high in quality, or task appropriate may vary from one person, task, or environment to another. Central to this ability is being able to re-define problems. Creative people may take problems that other people see, or they themselves may previously have seen, in one way, and redefine the problems in a different way. This synthetic ability includes three knowledge-acquisition components. The first, selective encoding, involves distinguishing relevant from irrelevant information. Selective combination, the second, involves combining bits of relevant information in novel ways. Finally, selective comparison involves relating new information to old information in a novel way.

The second element, practical ability, is needed to communicate creative ideas to other people (i.e., 'selling' an idea). Good ideas do not always sell themselves – the creative person needs to devise strategies for and expend effort in selling those ideas.

The third component, analytical ability, is often measured by traditional intelligence tests. Yet this component is also related to creativity, as a successful creator must be able to judge the value of his or her own ideas and decide which ones to pursue. Such analytical ability can be used to evaluate the strengths and weaknesses of the idea and determine the best steps to improve upon the idea. People who are high in synthetic ability but low in analytical ability may need someone else to evaluate and judge their work for them. People who are able incisively to evaluate their own work may be said to be high in metacognition (which is related to planning, a key component of Luria's model).

This model has been expanded recently by Sternberg (2018) into a triangular theory of creativity. According to this theory, creativity involves not only defiance of the crowd, but also defiance of oneself and of the Zeitgeist or worldview of one's society. Defiance of oneself means that one is willing to get go of one's prior beliefs and sometimes even creative work to focus on new ideas that may reject or perhaps expand upon one's original ideas. Defiance of the Zeitgeist involves letting go of the presuppositions that have in the past ruled one's creative work.

There has been some empirical work on the role of meta-cognitive abilities in creativity. Some studies have found that people who tended to produce more original responses also were better at rating their most original responses to a divergent-thinking task. In one study, people were asked to pick their best responses to a similar divergent-thinking task, and then examined whether they were more likely to choose responses that outside raters considered creative. Research found that people were able to discern their more creative responses – and that people who were more open to experience were more likely to choose accurately. Further, the concept of creative metacognition has also been proposed (Kaufman and Beghetto, 2013). This ability not entails accurately evaluating one's best creative ideas but also determining appropriate times to share these ideas.

A theory of giftedness that could be argued to be a Systems theory is Renzulli's (1986) Three-Ring Model, which proposes that giftedness is at the intersection among above-average intelligence (measured traditionally), creativity, and task commitment. The circles representing creativity and intelligence overlap. Renzulli distinguishes between two types of giftedness – schoolhouse (i.e., what would be measured by an ability or achievement test) and creative-production. Examples of his components of creativity include Guilford's divergent thinking components (fluency, flexibility, and originality), and being open to new experiences, curious, willing to take risks, and sensitive to aesthetic characteristics.

Another theory that views creativity as a mix of different abilities is Amabile's (1996) componential model of creativity. She argued that three variables were needed for creativity to occur: domain-relevant skills, creativity-relevant skills, and task motivation. Domain-relevant skills include knowledge, technical skills, and specialized talent (i.e., a creative mathematician should know basic algebra and geometry). Creativity-relevant skills are personal factors that are associated with creativity. These skills include tolerance for ambiguity, self-discipline, and risk-taking. Finally, Amabile singles out your motivation toward the task at hand. Intelligence would primarily occur at the domain-relevant skill level.

Cognitive Theories of Creativity

The other group of theories that includes intellectual abilities as a key component is the set of cognitive theories of creativity. Guilford, as discussed earlier, pioneered these ideas, and his convergent versus divergent thinking dichotomy is still a key idea in creativity. Even before Guilford, however, Wallas proposed a model of the cognitive creative process. According to his five-stage model, you first use *preparation* to begin work on a problem. Next, there is *incubation*, in which you may work on other things while your mind thinks about the problem. In *intimation*, you realize you are about to have a breakthrough (this phase is sometimes dropped from the model), and then you actually have the insight in the *illumination* phase. Finally, with *verification*, you actually test, develop, and use your ideas. The Geneptore model (Finke et al., 1992) has two phases, generative and explorative, that are comparable to Guilford's convergent and divergent thinking distinction. In the generative phase, someone constructs a preinventive structure, or a mental representation of a possible creative solution. For example, Elias Howe was working on his invention of the modern sewing machine. He could not quite get the needle correctly designed. Howe had an odd dream in which he was chased by savages who threw spears at him. The spears had a circle loop at the end – and Howe realized that adding the circle (or an 'eye') to the end of

the needle was the solution he needed. The image of a spear with a circle at the end – the image that preceded Howe’s insight – would be an example of one of these preinventive structures. They do not need to be as dramatic or sudden as the realization based on Howe’s dream. Indeed, the generation of preinventive structures is only one part of the creative process, according to the Geneplore model. The thinker must then explore these different preinventive structures within the constraints of the final goal. There may be several cycles before a creative work is produced.

Although the model focuses on the creative process, most tests of the model have actually measured the creative product. In an experiment testing the model, people were shown parts of objects (such as a circle or a cube). They were then asked to combine these parts together to produce a practical object or device. The creativity (and practicality) of the items was then assessed. Interestingly, people produced more creative objects when they were told which parts had to be combined than when they could pick the parts to be combined.

Other theories have also focused on cognitive-oriented components of the creative process. Michael Mumford and his colleagues have argued for an eight-part model, focusing on problem construction, information encoding, category selection, category combination and reorganization, idea generation, idea evaluation, implementation planning, and solution monitoring. Problem construction (also called problem recognition) has been found to particularly predict the overall creativity of a final product (Reiter-Palmon and Robinson, 2009). Mednick (1962) proposed the idea that creativity occurs when different elements are associated together to form new combinations. Creative individuals are assumed to be able to make meaningful, useful associations between disparate concepts and ideas to a greater extent than a relatively uncreative individual. The Remote Associates Test was developed based on this idea.

Robert Sternberg (2017) has proposed a cognitive model of creativity that is applicable to what Kaufman and Beghetto (2009) have called Pro-c (professional) and Big-C (historically significant) creativity. The model describes the sequence of phases people go through and their interaction with the environment when people think and act creatively. The model further specifies aspects of the relationship between creativity and intelligence. The model is referred to as the “straight-A” model of the creative process. It involves five variables—1. activators, 2. abilities, 3. amplifiers, 4. appeal to audience, and 5. assessment by audience. *Activators* are any forces that serve to provoke or to stimulate creativity. The forces can be internal to the person or external—in the environment. There are also deactivators—forces that discourage creativity, such as the time pressure and multiple-choice formats involved with standardized tests. Abilities, of course, include cognitive skills people need to be creative, such as creative, analytical, and practical intelligence. Amplifiers are forces that increase one’s propensity to be creative, such as, according to Sternberg’s triangular theory of creativity (mentioned earlier), willingness to defy oneself, the crowd, and the societal Zeitgeist (worldview). Appeal to audience is the creator’s attempt to fashion his or her work so as to have audience appeal. And assessment by the audience is the audience’s judgment as to whether the work is creative.

In related fashion, Vlad Glăveanu (2013) has proposed a “five A’s framework” for creativity, which includes the actor, action, artifact, the audience, and affordances). The actor (creator) acts creatively, producing an artifact for an audience, within the scope of affordances (opportunities) provided by the environment.

Theories on How Intelligence and Creativity Are Related

The threshold theory argues that intelligence is a necessary but not a sufficient condition of creativity. According to this view, creativity and intelligence are positively correlated up until an IQ of approximately 120; in people with higher IQs, the two constructs are said to show little relationship. The interference hypothesis suggests that very high levels of intelligence may interfere with creativity.

Empirical Work on Intelligence and Creativity

Most studies that investigate creativity and intelligence use divergent-thinking tests (such as the TTCT) or other related paper-and-pencil tests also scored for fluency, originality, or other divergent thinking-related methods of scoring. The studies have generally found that creativity is significantly associated with psychometric measures of intelligence (especially verbally oriented measures, regardless of the type of creativity measured). This relationship is typically not a particularly strong one, although some have argued that the relationship between the latent constructs of creativity and intelligence is underestimated because the analyses only look at observable scores (i.e., performance on an intelligence test). If it were possible to get a ‘true’ measure of the constructs, there might be a higher relationship.

The threshold theory has come under fire. Some have found that the nature of the relationship was dependent on the measures used and the populations tested. Others looked at measures of fluid intelligence and creativity (as measured through divergent thinking tests) and found modest correlations across all levels of intellectual abilities. A longitudinal study of gifted (top 1%) 13-year-olds revealed that differences in SAT scores – even within such an elite group – predicted creative accomplishments 20 years later (Park et al., 2007). A meta-analysis of 21 studies discovered virtually no support for the threshold theory, with small positive correlations found at all levels of ability between measures of intelligence and creativity (Kim, 2005). More recent studies using sophisticated statistical methodology, however, have provided some evidence for the threshold theory (Karwowski et al., 2016).

Nearly all of the studies discussed, however, have a major weakness: the over-reliance on divergent thinking measures as the sole assessment of creativity. Few studies have been conducted that include measures of creative personality, creative products, and

creative processes (other than divergent thinking). Given the distinct characteristics of assessments in these areas, highlighted throughout this book, the threshold theory may be best viewed as largely untested.

Conclusion

Intelligence is strongly valued in schools, and there are extensive and popular measures that are often used. There are usually hundreds of empirical studies about each intelligence test. Creativity may be theoretically desired in school but is often considered less important; some teachers may even dislike creative students. Creativity assessment is murkier than intellectual assessment. The Torrance Tests remain the most used creativity tests despite extensive critiques, although self-reports, teacher ratings, and the Consensual Assessment Technique are also often used.

Few studies contradict the idea that creative people tend to be fairly smart, and that smart people are usually somewhat creative. But some of the tested-and-true ideas about the specific relationship are still unclear. If the threshold theory is correct, then there may be a certain point at which being smart stops helping creativity; recent psychometric studies, however, call the existence of the threshold effect into question.

Both intelligence and creativity are essential component of learning and problem solving in everyday life. Nearly any problem, by the virtue of definition, imposes on its solver some ambiguity that needs to be overcome in order to find the solution. Some theories consider creativity to be subsumed into intelligence and others view intelligence as a core component of creativity. The need of both cognitive constructs in life, however, is undisputed.

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Intentionality

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Organizations compete in rapidly changing environments. In order to adapt, compete, and serve in these environments, there is a growing need for the generation of new and useful ideas, or creativity, in organizations. Educators, psychologists, social scientists, neuroscientists, organizational scholars, and even occupational therapists study creativity to gather a better understanding about these activities. An intentionality perspective (a perspective that considers purposeful thoughts and actions) adds value to the understanding of how creativity happens and provides new insights about fostering creativity. Considering the “doing it all on purpose” perspective opens the possibility that everyone can be creative, if the skills necessary for creativity are focused on and purposefully learned and practiced. As organizations depend on employees being creative and generating new ideas for processes and products, giving intentionality more attention as it relates to creativity may have deep implications for individuals and organizations as they pursue innovation strategies.

This chapter addresses the notion of intentionality, outlining first what it is closely related to and how it relates to creativity. Then, we provide a number of different ways in which intentionality can aid the creative process at a variety of different levels of analyses. Finally, we highlight how intentionality for creativity can be conceptualized and operationalized as a multi-level construct, residing at the individual, group, and organizational levels of analyses.

Intentionality

When you think about an object, you visualize it in your mind. When you draw an object, your mind guides you to find the correct lines to shape the drawing. When you talk with someone about a topic, your words refer to that topic. Your mind wants to be near and around what you do, how you feel, and how you understand things. In order to address this, Franz Brentano introduced intentionality into philosophy in the last quarter of the 19th century. The *Stanford Encyclopedia of Philosophy* defines intentionality as “the power of minds to be about, to represent, or to stand for, things, properties and states of affairs”. [Malle and Knobe \(2001\)](#) simplify this philosophical definition and use the term intentionality to mean *the purposeful decision to deliberately engage in some action*. Our intentions are expressed with the verbs decide, plan, and intend. When people drive their intentions towards creative activities, they intentionally try to generate creative outcomes.

While creativity scholars have noted the importance of intentionality for creativity, a variety of organizational theories and other fields of studies have long noted the importance of purposeful action by individuals. If we think about developing creativity as developing a competency or skill set, then using a frame of intentionality allows us to gain a number of new insights about fostering creativity in organizations. In order to understand the importance of intentionality and purposeful efforts, goal

setting theory by [Locke and Latham \(1990\)](#) and self-determination theory by [Ryan and Deci \(2000\)](#) are extremely useful perspectives.

Goal Setting Theory

Edwin Locke and Gary Latham propose goal setting theory to describe how developing an intentional plan motivates individuals to reach and be more creative about their goals. Goal setting theory refers to the development of a clear and measurable plan to motivate an individual toward a specific and difficult goal. Locke and Latham argue that both difficulties of a goal and self-efficacy, or confidence about their ability to complete the task, have positive relationships with an individual's performance. Later work of theirs further describes how goals affect performance through different mechanisms. First, goals direct individuals' attention and effort toward goal-relevant activities. Second, bigger goals lead to greater efforts than smaller goals. Third, harder goals extend the duration of the effort than easier goals. Fourth, goals affect performance by leading to arousal, discovery and task-related knowledge and strategies. When people are the most committed to goals, the goal to performance relationship is strongest. Also, individuals' self-efficacy, or confidence about the task, increases their goal commitment. Having summary feedback methods and complexity of task are other effective goal-setting influencers.

Additionally, past performance affects individuals' or groups' future goal choice. Learning goals improve planning and understanding of one's own thought processes toward goal attainment. A person's performance differs whether that person considers a difficult goal as a challenge or a threat. Locke and Latham also argue that goal setting theory can be applied to group and organization levels settings. Since intentionality is a key component of developing a goal-specific plan, being purposeful may be positively correlated with individuals' performance. Intentional plans direct individuals' attention and effort toward goal-relevant activities. Intentional plans improve planning and understanding of one's own thought processes toward goal attainment.

Self Determination Theory

Edward Deci and Richard Ryan propose self-determination theory to describe links between personality, human motivation, and optimal functioning. This theory was shaped by their previous studies about motivation in the 1970s and 1980s. Self-determination theory posits that there are intrinsic and extrinsic motivations and these motivations are strong forces in shaping our behaviors. Ryan and Deci define intrinsic motivation as engaging in something for self-satisfaction. Extrinsic motivation refers to engaging in behaviors for externally generated rewards. This perspective may be adopted to understand how intentionality that is internally generated, versus that which is coached to the individual by an outsider results in different creative outcomes.

The work of Ryan and Deci and self-determination theory has intentionality and purposefulness at its core. Their studies suggest that intrinsic motivation and self-satisfaction are positively correlated with intentionality and purposefulness. This suggests that in order to make purposeful changes in our lives, intrinsic rewards are more effective than extrinsic rewards. In fact, Ryan and Deci argue that self-determination and being in control of one's own life are positively correlated with one's self-motivation, mental health, and well-being, all of which should also set the stage for creativity.

Intentionality for Creativity at Different Levels of Analysis

Individual Intentionality for Creativity

Individuals can make choices to purposefully engage in activities related to creativity on their own volition. That intentionality and purposefulness will enhance one's intrinsic task interest, and thus, should increase that person's creativity. Purposeful and intentional awareness of the present situation becomes valuable to explain a person's creative behavior, creative performance and individual creative outcomes.

Divergent thinking is a connection point to make these predictions between intentionality and creativity. [Runco \(1993, 2007\)](#) states that individuals can increase their creativity by purposefully engaging in divergent thinking during the creative process. Since divergent thinking refers to analyzing many potential solutions in order to generate creative ideas, being purposeful towards doing this would make one end up with more potential creative answers for the problem. As a result, one can then intentionally and purposefully choose the best option among these potential solutions.

As discussed above, intentionality is not a fixed personality trait of a person, but rather a skill that one can develop over time with practice and a better understanding of the notion. It is a helpful tool in early education and development of individuals, but it is not restricted to early education. Educators' intentions and ability to provide a creative environment for students to develop creative solutions contribute to individuals' intentionality. Additionally, educators should also adopt an intentionality perspective to their own behaviors to provide role modeling about individual intentionality. This would help educators better understand their role in developing students' intentionality for individual and group creativity. With

proper techniques, human intentions can be directed toward changes in one's creative performance. Indeed, [Runco \(2007\)](#) states that if people can direct their intentions to enhance their creative performance, they can fulfill their creative potential.

A variety of different bodies of literature have linked intentionality either directly or indirectly to creativity. Specifically, though, which processes can individuals be intentional about engaging in order to stimulate creativity either in themselves or others, and at which levels of analysis do those processes operate? [Shalley and Gilson \(2004\)](#) take a levels of analysis approach in considering factors that relate to creativity at the individual, group and organizational level. They consider the leadership implications for these levels of analysis in terms of stimulating creativity. Their framework serves as an optimal foundation for considering not just leadership as they did, but for considering intentionality and creativity, for it highlights things critical to creativity that can be done with intentionality at all three levels of analysis. Taking an intentionality approach to leading creativity changes the lens and landscape for both our theoretical understand and specific action. An intentionality approach highlights even more the levels of analysis issues for the locus of control and locus of action for creativity. Individuals, leaders, groups and organizations are all entities that can adopt intentionality and influence creativity with specific, focused, and purposeful actions, which we describe next.

Creativity Skills

Individuals need a variety of skills necessary for creativity, including divergent thinking. Some of these skills are problem finding, problem definition or construction, combination, and idea evaluation. Each of these skills in the creative process can be done with intentionality and purposeful search. In fact, creativity is expected to be higher when individuals intentionally focus on the time and processes of these different steps. This additional purposeful search for creative solutions may increase the originality of the solution and result in a more desirable outcome.

Deepening Expertise

[Shalley and Gilson \(2004\)](#) highlight the necessity of expertise and experience that the creativity literature has long posited is critical for creativity. People can become experts in different topics after purposeful practice for a significant amount of time. Groups and organizations can develop core competencies, or become experts in, specific processes and knowledge areas. The focus of this vein of research has been around domain specific knowledge; in order to be creative and craft a unique solution for a specific problem, one must have domain specific knowledge, experience, or expertise in that area. However, more research on the relationship between purposefully deepening expertise should be conducted, as [Jaussi and colleagues \(2017\)](#) found no relationship of purposefully deepening one's expertise at work on the relationship between positive affect and radical and incremental creativity. While their work considers the individual level effects of purposefully deepening expertise and one's creativity, no research to date has further considered this variable or looked at it at other levels of analysis.

External Scanning

External scanning is something the strategy literature has discussed as critical for understand the competitive environment of the organization, and the creativity literature has highlighted its importance for increasing creativity. [Dane \(2010\)](#) discusses the need for experts to reach out into dynamic environments and knowledge areas beyond their domain of expertise in order to circumvent the cognitive entrenchment that can occur with deep domain-specific expertise. Again, without specifically calling it "intentionality", Dane's theorizing implicitly hinges on experts having the intentionality to avoid cognitive entrenchment and purposefully engage in these two primary activities to increase their cognitive flexibility.

Building Creative Self-Efficacy

Creative self-efficacy, or the confidence one has in their ability to be creative, is related to creativity. While things such as supervisor actions, role identity, and transformational leadership have been found to impact one's creative self-efficacy, taking an intentionality lens and applying it to creative self-efficacy moves something potentially considered relatively static in our current research approach (e.g. individuals either have high, medium or low creative self-efficacy and then we consider the implications of that) to a different place of agency. An intentionality perspective would suggest that individuals can be responsible for intentionally knowing their current levels of creative self-efficacy and then engaging in creative tasks to gain confidence and mastery in creativity. Additionally, taking an intentionality approach to creative self-efficacy may suggest that people may intentionally seek out role models in creativity to learn vicariously from them.

One Note of Caution, However, About Intentionality

Some things that individuals do intentionally that work for other types of activities may actually hamper creativity. Measuring and monitoring behaviors related to creativity may be one such example. Long hailed by behavioral modification and goal setting theorists as critical to successful change and goal attainment, measuring and monitoring is often discussed as necessary to keep one's focus on engaging in the behaviors. Yet, measuring and monitoring might have a restricting effect on one's creativity as it will interrupt expression and mental flow, and divert attention from creativity-enhancing processes. In fact, in their research, [Jaussi and colleagues \(2017\)](#) suggest this to be the case. They found that the relationship between positive affect and incremental creativity was significantly weaker when purposeful monitoring was high than when it was low. Erik Dane also reinforces this in his work about mind-wandering. He describes mind-wandering as both an involuntary and voluntary phenomenon, and suggests that not over-focusing, but rather intentionally letting your mind wander, can be beneficial for creativity. Thus, with respect to creativity,

individuals will want to be careful with intentionality about things that may work in other domains as they could significantly negatively impact or inhibit other processes that facilitate creativity.

While individual intentionality regarding certain processes related to creativity can facilitate individual creativity in oneself or others, intentionality can also exist at other levels of analysis as well. Next, we discuss group level intentionality, and consider how intentionality at this higher level of analysis is related to group creativity.

Group Intentionality and Group Creativity

Research on group creativity is growing in volume and in importance, as groups and teams are increasingly popular in organizations. Leadership, group processes, and team composition are important factors for increasing group creativity. Considering intentionality at the group level helps us further understand and theorize more about the kinds of things that may be related to group creativity. Group intentionality identifies the intentionality that happens when two or more members engage in purposeful processes and actions collectively.

As the interactions and exchanges of individuals' unique intentional expressions in a group may result in creative outcomes, groups should intentionally stimulate interactions and exchanges among individual members in order to leverage the benefits of group diversity. To do this, group members may intentionally stimulate collaborations and connectivity in their social networks. Further collaborations in these creative and innovate environments will lead to creative solutions. Group members should intentionally aim to sustain their contribution and use these sustained contributions in the group discussion to generate creative ideas. Brainstorming is one example of a purposeful activity that group members can use to intentionally stimulate these types of social cognitive influence processes. In forming groups, group leaders should intentionally select team members for diversity and design processes to intentionally stimulate interactions amongst the diverse members in the group.

Harvey (2014) theorizes how groups and teams should purposefully create creative synthesis in order to facilitate the highest levels of creativity possible. She further underscores groups needing to engage in intentionality with respect to generating collective attention, or making sure group members are focused on the importance of creativity or creativity goals. She also describes the importance of another intentional behavior of groups, engaging in the enactment of ideas, in order to achieve creative synthesis.

Group Positive Affect

Groups should intentionally create positive group affect, or positive emotions and feelings, in order to facilitate group creativity. Positive affect is both a trait and state variable, meaning that while individuals can possess it naturally, it can also be induced by external factors. A large body of work has pointed to how positive affect can open cognitive channels, or allow individuals to broaden and build their thoughts and associations and form more novel connections amongst ideas (Fredrickson, 2001). Group positive affect can produce these same novel connections amongst group member ideas, thereby contributing to and facilitating group synthesis (Harvey, 2014).

Thus, intentionality for creativity at the group level should focus on purposefully stimulating collaborations and connectivity in social networks, stimulating interactions and exchanges in order to leverage diversity, stimulating cognitive influence processes through brainstorming, and creating group positive affect.

Organizational Design for Organizational Intentionality

The field of organizational design, by definition, holds as a core premise that organizations can and should be purposefully and intentionally designed to create conditions for social and technical interactions and outcomes to occur. Jay Galbraith (1977) proposes organizational design to define the organizational structure and understand the relationship among its components. As noted on Galbraith's website, "Organization design is the deliberate process of configuring structures, processes, reward systems, and people practices to create an effective organization capable of achieving the business strategy."

Organizational design should include up to date technology and information flow in socio-economic systems in order to achieve success in highly competitive environments. People need to understand the technology and information flow to perform more creatively in organizations. Intentional behaviors are helpful to understand the environmental, social, and personal impacts of our daily life decisions. Thus, purposeful commitment to these factors stimulates individuals' learning and creative processes.

An intentional, innovative and interactive environment reshapes intentions and triggers the creative thinking processes of individuals. With this perspective, intentionality and the purpose of creating value may determine how innovative solutions are created. Moolenaar and colleagues (2014) argue that individuals' high intentionality in connecting and interacting with others is positively correlated with their recognition of organizational climate as being more innovative. Therefore, these interactions among peers create a fruitful environment that frequently produces creative ideas. Being purposeful in every part of an action is critical to create a highly connected social network. Therefore, understanding the technology and information flow between and within organizations, and improving collaborations and connectivity of organizational social networks enhance the creativity among individuals and provide innovative and creative environments.

Organizational intentionality for creativity involves purposeful design for systems that foster creativity, such as reward systems, systems that encourage disruption, questioning, and even destruction, and the purposeful inclusion of contextual enablers for creative leadership in their intentional design for creativity.

Reward Systems

Organizations with a creativity and innovation agenda will benefit from intentionally designing systems that reward individuals for their efforts at intentionality around all things related to creativity. Such a design will be a departure for most organizations, who tend to reward around outcomes rather than processes. Adopting an intentionality perspective at the organizational level of analysis suggests that the organization will reward individuals wanting to try, as well as rewarding those who intentionally focus on the more upstream processes for creativity instead of just the outcome. Creativity research scholars have noted the importance of reward systems for creativity. For example, [Amabile \(1998\)](#) describes in great detail how organizations without rewards systems for creativity can “kill” creativity. [Baer and colleagues \(2003\)](#) looked at how reward systems in organizations can facilitate creativity from employees. Interestingly, their research found that rewards boosted creativity in employees who were faced with relatively simple tasks rather than complex ones.

Design for Disruption

Organizations can also be designed in ways that facilitate and celebrate disruption, even going so far as to encourage destruction. As [Runco \(1993\)](#) notes, creativity by definition involves unconventionality and destruction of existing structures and processes. Organizations should have systems in place to encourage questioning, irreverence, and bringing ideas that disrupt or destroy status quo approaches to markets, customers, or operations. Undoubtedly, any organization would benefit from employees bringing disruptive, creative ideas forward.

Contextual Enablers

Additionally, as [Randel and Jaussi \(2019\)](#) note, organizations can also intentionally design organizational level factors that will enable creative leadership. Organizational intentionality focused on enabling the rise of creative leadership will help creative leaders emerge and thrive, which should then further creativity throughout their respective units. Randel and Jaussi highlight how designing for organizational heterogeneity, redesigning processes for the encouragement of entrepreneurial action, and intentionally building the organizational culture to value taking time to fully identify and research problems will facilitate the emergence of creative leadership.

Conclusion

This chapter has described intentionality and its grounding in two closely related constructs, goal-setting theory and self-determination theory. Additionally, it described how intentionality for creativity can increase the likelihood for creativity at the individual, group and organizational levels of analysis. While we know a great deal about how certain phenomena like creative self-efficacy relate to creativity, research and practice would benefit from adopting an intentionality perspective as well, for it allows for the focus to be on purposeful actions that can be taken to increase creativity. As a multi-level phenomenon, occurring at and between the individual, group, and organizational levels of analysis, it opens up a number of fascinating implications and agendas for future research and practice. We hope that our work has been catalytic in inspiring such agendas, and that the creativity world will soon be tasting the sugar and spice of intentionality on creativity. Just as the training literature had to evolve to include training motivation in its theorizing, the time has come to include intentionality in more of our creativity research.

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Interdisciplinarity Creativity

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Introduction

Creativity is a complex system which involves not only the creative person and process, but also the creative product and environment. Each of these dimensions contains a variety of components covering different disciplines such as psychology, sociology, arts, history, business, education, etc. In addition, creativity can be manifested at different levels, ranging from eminent, high-level creativity to personal and everyday creativity and in different domains such as discovery in science and geography, design in arts, invention in engineering and technology, reform in politics, changes in society and innovation or entrepreneurship in business, etc. The complex nature of creativity means that creativity cannot be sufficiently explained from only one discipline. Interdisciplinary approaches combine theories and practices of different disciplines and can help obtain a better understanding of creativity. Meanwhile, interdisciplinary communication and collaboration is a creative process, as people of different disciplines need to apply creativity to bridge gaps and create new combinations. Interdisciplinary approaches are often used to foster creativity.

Different Ways of Bringing Disciplines Together

The word “discipline” originates from the Latin words “discipulus” and “disciplina”, which means pupil and teaching respectively. This semantic origin implies that discipline is inherently related to education, whose major activities involve the transmission, transfer, production, and reproduction of knowledge and the development of competences and skills. Scholars have a long history of categorizing different fields of knowledge for learning and teaching purposes. For example, Plato’s academy in 387 BCE focused on Pythagorean number theory, advanced geometry and speculations on science as well as social issues such as education, jurisprudence, politics, and sex. Aristotle’s Lyceum in 335 BCE extended the classification into a wider scope covering different areas which can be further categorized into three classes, including theoretical (knowing and understanding), practical (doing) and productive (making or creating). The appearance of the so-called “scientific disciplines” occurred in the 19th century and since then the division of disciplines has been used by society and educational institutions to classify and organize teaching, learning, and the roles of different professions.

Contemporary universities tend to differentiate two major academic areas - arts and science. The typical artistic disciplines include fine and performing arts, humanities and social sciences. The typical scientific disciplines include natural sciences, mathematics, technology, engineering, and medical fields. It is worth noting that disciplines are not static. The meaning, characteristics and classification of disciplines continuously change when new challenges and demands of society emerge, new discoveries take place or new technologies appear.

There are different ways to bring disciplines together. Scholars advocate a clear distinction among them according to the degree of integration of disciplines. The typical classification is composed of the so-called pluri- or multidisciplinary, interdisciplinarity, and transdisciplinarity (e.g., Klein, 2010).

Pluri- or Multidisciplinary

Pluri- or multidisciplinary combines knowledge and contributions from two or more disciplines without synthesizing or integrating them. In a multidisciplinary team, members work independently rather than interactively. A typical example of such an approach is the writing of this encyclopedia. Hundreds of scholars from a wide range of disciplines come together to present their knowledge and share their opinions about a common topic – in this case, creativity. There is an agreed structure and content paradigm with the editors before compiling the encyclopedia. But once the writing starts, there is no interaction between the authors. Though representing the lowest level of integration, the multidisciplinary plays a valuable role in establishing epistemological foundations for a given subject area, project or program. Therefore, this approach is still widely used.

Interdisciplinarity

Interdisciplinarity takes one step further to not only bring knowledge and contributions of various disciplines together but also synthesize and integrate them through intensive interaction and collaboration. In an interdisciplinary team, members apply different methods, knowledge, and types of thinking of different disciplines to solve questions or complete tasks so that each discipline gains more than it would by working alone. Examples of interdisciplinarity include the development of merging interdisciplinary disciplines such as biochemistry, bioinformatics, neuropsychology, cognitive economics, and organic electronics.

Transdisciplinarity

“Trans” means going across, over or beyond. Transdisciplinarity transcends the boundaries of disciplines through intensive collaboration of disciplinary experts, social practitioners and stakeholders, thus new perspectives, knowledge or systems can be created. The emergence of the transdisciplinarity is closely related to the contemporary epistemological quest for systematic integration of knowledge, synthetic paradigms, problem solving and societal movements for change. Typical examples of transdisciplinarity involve efforts of scientists, politicians, non-scientists, and other stakeholders to cope with complex health problems such as cancer or environmental problems such as climate change.

Transdisciplinary requires the highest level of disciplinary integration of the three. The combination of knowledge from multiple disciplines without synthesis can broaden the horizon but not necessarily foster creativity. The transcendence of disciplines can lead to the creation of new knowledge and systems, but it takes on board not only scientists but also political, social, and economic actors, and even ordinary citizens, thus entails massive investment of time and resources for coordination and management. Not surprisingly, interdisciplinary approaches are more frequently applied in universities and companies to achieve creative and innovative goals. As a result, the focus of the current entry is interdisciplinarity and creativity. Throughout the chapter, interdisciplinary and interdisciplinarity approaches are used interchangeably.

Interdisciplinarity and Creativity Studies

Scholars have agreed that creativity contains at least two defining characteristics: originality and effectiveness (also often labeled as usefulness, fit, or appropriateness). The achievement, expression, and evaluation of the originality and effectiveness involves the participation and interaction of multiple factors in and outside the person. Therefore, creativity can be optimally studied only if multiple components such as motivation, emotion, cognitive abilities, and environment are taken into consideration. Reviews of the status quo of creativity research for the past decades, however, reveal that knowledge about creativity is fragmented and the collaboration among scientists of different disciplines and between scientists and different stakeholders is still limited (e.g., Hennessey and Amabile, 2010). Therefore, calls have been made to make interdisciplinary efforts in studying creativity.

Runco (2007)'s book *Creativity: Theories and Themes: Research, Development, and Practice* was among the first that adopted an interdisciplinary approach. In this book, Runco pointed to the complex and multifaceted nature of creativity and suggested an eclectic approach. He brought together studies from a wide range of fields including behavioral, clinical, cognitive, developmental, educational, organizational, social, economic, historical, and evolutionary perspectives. In the second edition of the book published in 2014, he added two new chapters, including philosophy and creativity, and politics and creativity.

In his second edition of *Explaining Creativity: The Science of Human Innovation*, Sawyer (2012) brought together scientific studies from different disciplines including individual psychology, developmental psychology, cognitive psychology, organizational

psychology, cultural psychology, computer science, neuroscience, biology, arts, and history, etc. As a conclusion, he foresaw the future creativity study to become increasingly interdisciplinary.

In 2017 three important edited books contributing to the interdisciplinary approaches to creativity studies were published. *The Cambridge Handbook of Creativity Across Domains* edited by Kaufman et al. (2017) focused on the complex relationship between domain-general vs. -specificity in creativity. The authors brought together top experts from around the world to discuss creativity across a large number of different domains that cover both traditional domains (e.g., visual art, music, play, dance, engineering, teaching, architecture and psychology) and less traditional domains (e.g., sports, craft, emotions, and photography). One chapter of the book even discussed about animal creativity. What is special about this book is that each chapter discussed the definitions, intriguing research, and potential measures of creativity before making suggestions for development or future directions. This template enabled the exploration and cross-disciplinary comparison of the study and development of creativity in different domains. For example, through the comparison, it is clear that different disciplines give different weight to different criteria in defining creativity: architects emphasize aesthetics in addition to originality, usefulness in photography is defined by the elicited emotional responses in viewers, and in the case of law, institutional constraints and norms are of vital importance. In terms of personality, extraversion appears to be related to creativity particularly to everyday and entrepreneurial creativity, conscientiousness seems relevant to sciences but not arts, and mental illness seems to occur twice as often among writers than non-writers. They anticipate the future as domain transversal and advocate a more pragmatic approach to explore “how and when we can generalize findings and tools from one domain of activity to others or how domain general knowledge or approaches can help us intervene in applied domains” (p. 642).

Acknowledging the need of the dialogue between creativity and innovation, Tang and Werner (2017) summarized their interdisciplinary and intercultural approach to creativity into the *Handbook of the Management of Creativity and Innovation: Theory and Practice*. Their book was inspired by two gaps in the existing bodies of literature: the separation of the creativity and innovation studies and the gap between theories and practice. This book brought together scholars and practitioners from the fields of psychology, education, business, engineering and law to discuss how creativity and innovation are perceived, studied, and managed in different fields and cultures. The authors pointed out that creativity cannot always be transformed into innovation because of the influence of various constraints. They emphasize that “teachers, managers and entrepreneurs need to strike a fine balance between flexibility and control and should adapt the multilevel approach to manage creativity and innovation effectively” (p. 360).

Inspired by the major trends of the contemporary society and the common spirit of openness, collaboration, and innovation, Darbellay et al. (2017) provided a space of dialogue and reflection for scholars and practitioners who are working on design thinking, creativity, inter- and transdisciplinarity, or at the interface of the three areas through their edited book *Creativity, Design Thinking and Interdisciplinarity*. This book brings studies of interdisciplinarity (ID), creativity (C) and design thinking (DT) from the perspectives of psychology, sociology, and epistemology, etc. and explores the complex links between them. The authors of the book reflected on the possible articulations and convergences between C, CD, and ID and highlighted the processes of creative design thinking from an interdisciplinary perspective.

Interdisciplinarity and Creativity in Education

The fast development of modern society has set new requirements on the development of talents. The T-shaped professionals, who have both deep disciplinary knowledge in at least one area and, at the same time, obtain the ability to function and collaborate across a variety of different disciplines and social, cultural, and economic boundaries are in high demand. Interdisciplinary practices can provide a space for teachers and learners to make connections between boundaries, imagine new ways of doing things, explore alternative options, and engage in a personal transformative experience. Below are some typical interdisciplinary approaches that have been successfully applied to foster creativity in education.

Problem-Based Learning (PBL)

Problem-based learning (PBL), also known as inquiry learning, is a student-centered pedagogical approach where students obtain knowledge and skills through the process of solving an open-ended problem. The PBL was first introduced at the Medical School of the McMaster University Canada in 1960s. Since then PBL has been broadened in application not only in medical education but also in almost all fields of learning. The PBL pedagogy draws on the theory of Constructivism, which emphasizes self-directed and collaborative learning in teams. In the PBL process, students work on real-world problems in groups and use the “group intellect” to collect data and information from different areas or domains about the problem. They also take an active part in brainstorming and group discussion to try to bring different subject areas and perspectives together to analyze the problem and propose solutions. There is evidence that PBL is effective in developing higher order thinking such as critical and creative thinking (Masek and Yamin, 2011).

Phenomenon-Based Learning (PhBL/PhenoBL)

Phenomenon-based Learning (PhBL/PhenoBL) is an interdisciplinary constructivist pedagogy where learning is organized in a phenomenon-based, holistic approach instead of a subject-based approach. The learning and pedagogical theories behind the

PhenoBL are actually the same as the PBL. The difference between them is that the PhenoBL is usually used as an umbrella concept which also includes inquiry learning, PBL, project-based learning, etc. In 2016, Finland began implementing a national curriculum reform and mandated that PhenoBL be introduced to the school system alongside the traditional subject-based instruction.

PhenoBL motivates students to learn by studying real-world relevant phenomena. A phenomenon is regarded as anything that can be observed or perceived. In schools, special attention is called to phenomena that are unusual (e.g., natural wonders), interesting (e.g., megatrends) or important (e.g., refugee crisis; integration). It enables the students to break the boundaries of the typical school subjects and develop 21st century skills such as teamwork, communication and critical and creative thinking. The success of such a pedagogical method is obvious: Finland has been best performing country overall in Europe in the Program for International Student Assessment (PISA). And Finland ranks among the top 10 most innovative countries of the world according to the Global Innovation Index.

STEM and STEAM Education

STEM is the acronym of Science, Technology, Engineering and Mathematics. This term is typically used to address educational policy and curriculum choices in schools or universities to improve competitiveness in science and technology development. STEM education is emphasized in many countries because knowledge and skills of these disciplines have strong impact on the development of new technologies, which are crucial for disruptive innovations. However, STEM disciplines are inherently rigid, analytical and logical. The interdisciplinary integration of these disciplines can bring about valuable deliverables, but the potential of coming up with disruptive integrations between these disciplines is limited. As a result, arts has been advocated to be added to STEM in recent years and in 2013 a transdisciplinary, international, open-access journal called "The STEAM Journal" was inaugurated. STEAM relies on breaking down the boundaries between the "hard" sciences and the "creative" arts, thus enabling the students to apply STEM knowledge in imaginative designs in their search for creative approaches to solve real-world problems. STEAM programs add art to STEM curriculum by drawing on design principles and encouraging creative solutions. Inquiry, collaboration (not only in learning but also in teaching), and an emphasis on process-based learning are at the heart of the STEAM approach.

Entrepreneurship Education

In a similar vein, entrepreneurship education brings real-world problems directly from schools, companies or society and relies on interdisciplinary teams to find possible solutions to the problems. Students of various disciplines go through typical design thinking process such as empathizing, defining, ideation, prototyping, and verification to develop concrete processes or products for the problems. Entrepreneurship education seeks to provide students with the knowledge, skills and motivation to encourage entrepreneurial success in a variety of settings.

Entrepreneurship education is carried in three major forms: (1) Regular Entrepreneurship (Start-ups). This is the most popular form of entrepreneurship education. More and more universities worldwide have their own entrepreneurship centers where they work with entrepreneurship consulting companies, companies, start-ups, and incubators, to offer regular courses, selective courses, workshops, summer schools or exchange programs to develop skills and competencies for entrepreneurship. Some programs run a business incubator onsite and operate over a long time period (usually 1–2 years); (2) Corporate entrepreneurship or intrapreneurship. This type of entrepreneurship education takes place at companies that set up a platform where employees can pitch their ideas. Selected ideas then have the chance to be further fostered by being worked through in a cross-functional team, obtaining entrepreneurship training, and other resources. Intrapreneurship is growing quickly: Big companies like Google, Facebook, Microsoft, 3 M, Siemens, and BMW, etc. all have their own intrapreneurship programs; (3) Social Entrepreneurship (Social Venturing). This type of entrepreneurship uses start-up companies and other entrepreneurs to develop, fund and implement solutions to social, cultural, or environmental issues. Social entrepreneurship targets important social problems through cross-disciplinary collaboration with different stakeholders and are either non-profits or they combine for-profit goals with generating a positive "return to society".

Interdisciplinary Research

Interdisciplinary research integrates information, knowledge, data, tools, techniques, concepts, and theories from different disciplines, thus offering the potential of advancing understanding, making new discoveries or solving complex problems. The nature of society and human life is inherently complex. For example, climate change has caused wide concern around the world. But climate change is not only an environmental problem, it is a problem closely related to consumption behaviors (e.g., meat and fast food consumption; plastic packing), globalization and mobility (e.g., ease of traveling by car and plane; flying is cheap and fast), psychology (e.g., selfishness; short-sightedness; inflexibility to give up convenience), business and economic behavior (e.g., aggressive and profit-oriented), and politics (e.g., The Paris Agreement; the recent restriction of diesel cars in Germany). Such complex problems cannot be solved by one discipline alone. Scientists of different disciplines need to work together to advance understanding and search for solutions. To implement their solutions and bring substantial changes, they need more involvement and support from stakeholders at different levels and from the whole society. Meanwhile, the fast development of modern technology provides new ways of learning, living and working, but new technology also poses problems and challenges. For example,

the wide use of Internet and social media has brought tremendous fun and convenience to us, but at the same time, problems of infringement on privacy, obesity, cybercrime, and other problems are challenging the health and safety of people.

As a result, interdisciplinary research has been widely advocated. For example, the US National Science Foundation (NSF) explicitly promotes and supports innovative research projects that require the involvement of several disciplines while exceeding their strict limits to develop new or emerging fields. In the European Union, initiatives such as Citizen Science, Open Science, or Science 2.0 reflect the increasing desire for more demand-driven and participatory research through interdisciplinary collaboration. The Cooperation in Science and Technology (COST) is an initiative to foster bottom-up creativity in research by enabling researchers from academia, industry and the public and private sector to work together in open networks that transcend borders, stimulates knowledge sharing, pools resources, and advance science. The Future and Emerging Technologies (FET) initiative is home for interdisciplinary research, where collaborations between biologists, mathematicians, chemists, psychologists, computer scientists, climate experts, social scientists, neuroscientists, physicists, designers, artists, doctors, engineers, economists and others are participating.

Interdisciplinarity and Team Creativity in Business

Functional Diversity and Team Creativity

Interdisciplinarity in organizational settings is usually understood as diversity in job-related diversity such as functional background or job knowledge-related attributes. There are different types of diversity such as demographic diversity (e.g., age, gender, nationality, etc.) and trait diversity (e.g., personality, cognitive styles, etc.). The focus of the current entry is on functional diversity.

In business and industry, teams composed of members of different functions or expertise are often used to carry out creative tasks and achieve innovative goals, such as product design and production, research and development, or marketing. To date, meta-analyses have slightly supported the positive relationship between functional diversity and team innovation. In one meta-analysis of 104 independent studies, a small effect size (average $r = 0.16$) was found between job-related diversity and team creativity (Hülsheger et al., 2009). The small effect of the interdisciplinarity on creativity in business could be due to the double-edged effect of diversity on creativity. The positive side is that people from different functional backgrounds bring different knowledge, expertise, skills and perspectives together and this could increase the chance of coming up with new ideas or solving complex challenging problems that cannot be solved by one discipline alone. The negative side is reflected by the fact that “Birds of a feather flock together.” Similarity breeds attraction. People have a natural tendency to communicate and interact with people who have similar attitudes, values and beliefs. Meanwhile, due to lack of understanding and different mindsets, people of different disciplines tend to think their own disciplines better than the others. This social categorization process will often lower the quality of communication and collaboration, decrease team cohesiveness and heighten relational conflict, which are all detrimental to team creativity. Hence, it is recommended that researchers look deeper into the team process (e.g., vision, external communication, support for innovation, task orientation, and internal communication; Hülsheger et al., 2009) and examine how the relationship between team diversity and team performance (including creativity) are mediated or moderated by variables related to task characteristics, team climate, leadership styles, managerial support, and organizational culture, etc (van Knippenberg, 2017).

Factors Between the Functional Diversity-Creativity Link

Interdisciplinary efforts involve not only the management of knowledge but also the management of the creative process. Many person-, system-, or environment-related factors influence the link between the functional diversity and creativity in business. Through a systematic review of the existing studies, Knippenberg (2017) revealed that functional diversity can be translated into creativity through the intermediate facilitating effect of the effective exchange of information among team members, their boundary spanning abilities and their communication with external members. He also found some factors influence the strength or direction of the link between functional diversity and creativity. For example, functional diversity is more likely to lead to creativity under one of the following conditions: (1) when the manager has a participative (i.e., shares the decision-making abilities and practices social equality) or transformational leadership style (i.e., serves as a role model, inspires and motivates followers, helps followers with self-actualization, challenges followers to be creative); (2) when the team climate is more supportive of innovation; (3) when the team is more open-minded; (4) when the team members are able to take perspectives of others. The influence of other factors in the complex relationship between interdisciplinary and creativity need to be tactfully managed to get creative outcomes from diversity.

Challenges and Recommendations

As mentioned, diversity (including interdisciplinary or functional diversity) has a double-edged effect. To leverage the positive potential of disciplinarily (or functionally) diverse teams, we need to manage the paradoxical effect tactfully. This section will summarize typical challenges of applying interdisciplinary approaches to creativity and make recommendations on how to meet these challenges.

How to Communicate in Interdisciplinary Teams?

The fact that different disciplines have different jargons and use different methods approaching problems may cause stress, biases, stereotypical thinking or misunderstanding in communication. Therefore, an important step in the interdisciplinary approach involves overcoming of differences in jargon and methodologies and the development of a common language. The following approaches can be helpful to promote the communication in interdisciplinary teams: (1) Each discipline should take time to learn basic jargons and terms of other disciplines; (2) Each discipline should learn to appreciate the value of differences; (3) Project managers can create an easily understandable cognitive diagram to guide the cognitive communication of the team; (4) Communication should occur frequently at different levels to make sure that problems are communicated and addressed in a timely manner; (5) Both internal and external communication should be utilized to obtain necessary support and resources to translate interdisciplinarity into team creativity.

How to Deal With Conflicts in Interdisciplinary Teams?

Conflicts break harmony and cause stress and tension, therefore, many people try to avoid conflicts. However, this attitude is irrational. Creativity studies differentiate two major types of conflict: Task (or cognitive) conflict vs. relationship (interpersonal) conflict. Task conflict is caused by differences in opinions or perspectives which are typical for interdisciplinary teams. Relationship conflict often results from personality differences, between individuals. A recent literature review of over 30 relevant studies provides evidence that task conflict has a positive effect on innovation whereas relationship conflict has no effect or a negative effect on innovation (Vollmer, 2015). Therefore, it is advisable that interdisciplinary teams should (1) be aware that harmony and comfort in a team can kill creativity as this might be the beginning that teams stops creating new things; (2) learn to differentiate different types of conflict and get ready to embrace constructive task conflict, which is conducive to creativity; (3) formalize the communication processes to make the conflict management a proactive tool for managers; (4) establish a supportive cohesive team environment so that interdisciplinary teams can effectively use conflict to improve creativity and innovation.

How to Integrate Different Disciplines?

Well-designed programs which provide effective interdisciplinary communication and collaboration can lead to creative solutions to problems. Luckie et al. (2013) compared three types of interdisciplinary experiences of students from chemistry, biology, and history of science courses: the low-dose model, where students heard cross-disciplinary references from the other disciplines and experienced periodic interdisciplinary exercises; the medium-dose model, where students of different disciplines work collaboratively in their labs; or the high-dose model, where students and faculty members in all three courses met on a weekly basis for discussions to draw connections across the disciplines. They found that the high-dose model had the greatest impact in transforming students' views and achieving creative results. This study suggested that the effective interdisciplinary learning requires sustained effort and frequent communication over time with recurring opportunities for students to identify and explore topics that bridge the disciplines. Critical reflection and metacognition are essential to interdisciplinary learning. Digital tools such as e-portfolios, e-mindmaps, online archives, design labs, and makerspaces are frequently used to facilitate the reflections of interdisciplinary teams and facilitate the interdisciplinary collaboration.

How to Evaluate the Success of Interdisciplinary Efforts?

One recent study of 900 research-center-based scientists and their 32,000 published articles concluded that interdisciplinary research is a high-risk high-reward endeavor: high-risk because interdisciplinary research suffered from a low productivity in acceptance for publication; high-reward as measured by increased citations once published (Leahey et al., 2017). The authors, therefore, suggested that the scientific community needs to consider different ways to evaluate scholarship for scientists engaged in interdisciplinary research.

In functionally diverse teams in business, the time and resources needed to construct, coordinate and manage teams can be at the cost of the productivity of the teams. As in educational settings, the adaptation of an assessment system for interdisciplinary projects can be an effective way to balance productivity and creativity. The complex nature of interdisciplinarity and creativity implies that the traditionally quantity-based summative evaluation is not suitable for assessing interdisciplinary efforts. Rather, formative evaluation of the process of team building, communication, collaboration, conflict management, idea generation, the originality and potential usefulness of the collaborative outcomes and idea implementation should also be measured to improve individual and team development. Flexibility in the evaluation of the outcomes of interdisciplinary collaborative projects is needed because new unplanned outcomes might occur.

How to Lead Interdisciplinary Teams to Achieve Creative Goals?

Interdisciplinary efforts involve not only the management of knowledge but also the management of the creative process. Therefore, the importance of creative leadership cannot be underestimated. As mentioned in the previous section, leadership styles, particularly the participative and transformational leadership styles are important mediating factors which enable the translation of functional diversity into creativity. A recent study found that these two leadership styles, particularly transformational leadership, are indeed important predictors of creativity (Mainemelis et al., 2015). In contrast to transactional leaders, who focus on supervision, control, organization and performance, transformational leaders emphasize inspiring, empowering, and stimulating followers to exceed normal levels of performance. Whereas transactional leaders lead through rewards and punishments, transformational leaders lead through personal-coaching/mentoring and allow followers to have freedom of choice (Bass, 1998). Participative

leadership, also known as democratic leadership style, describes the leaders who involves all team members in goal setting, problem solving, strategy development and task implementation. Participative leadership has a strong positive effect on innovation, as team members feel respected and empowered, thus more motivated.

In addition to the above-mentioned creative styles, Mainemelis et al. (2015) summarized the creative leadership into three major purposes: facilitating, directing and integrating (heterogeneous creative contributions). They stressed that a successful creativity leader of diverse teams should also embrace and balance competing demands on creative leaders such as novelty vs. usefulness, idea generation vs. implementation, cooperation vs. competition, and exploration vs. exploitation.

Conclusion

Interdisciplinary approaches have been widely used in creativity studies, education and organizations to help understand complex phenomena and foster creativity. However, the implementation of such approaches poses challenges for communication, conflict management, evaluation, leadership and management. Therefore, more studies should be carried out to examine the relationship between interdisciplinarity and creativity, and more practices are needed to help improve the management of diversity, creativity, and innovation.

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- Committee on Facilitating Interdisciplinary Research (CFIR): <https://www.nap.edu/initiative/committee-on-facilitating-interdisciplinary-research>.
- Global Entrepreneurship Monitor (GEM): <https://www.gemconsortium.org/>.
- Social Entrepreneurship Akademie (SEA): <https://seakademie.org/>.
- Center for Creative Leadership: <https://www.ccl.org/>.

Interior Design

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Introduction

Interior design, by nature, involves the act of creation. Creative interior design makes our lives comfortable, enjoyable, rich, safe, healthy, efficient, and organized. It inspires us, transforms our lifestyles, and helps us realize the beauty of surrounding space and every day artifacts. An interior space astutely choreographed can positively influence people’s day-to-day behavior, micro- and macroscale social interactions, multidimensional perception and emotion, and eventually physical and psychological well-being.

Creativity is a critical attribute for interior designers, and nurturing creative problem-solving skills is one of the significant goals of higher education (Runco, 2004); however, design is a complex and somewhat mysterious activity encompassing “many intangible elements, such as intuition, imagination, and creativity” (Zeisel, 2006, 19). Thus, understanding the creative design process is hardly easy and only partially possible from inference through the observation of the behavior of designers, produced artifacts like sketches and drawings, interview, and analysis of designer’s verbal protocols.

The rich relationship between interior design and creativity has been somewhat fragmentally discussed thus far. From the perspective of creativity as a multifaceted phenomenon, we address interior design creativity in terms of product (qualities of creative interior design), process (strategies for creative outcome), and person (prerequisites for creative interior designers). Instead of dealing with creativity in general, we discuss the special link between interior design and creativity by proposing a synthesized framework for a domain-specific understanding of creativity in interior design.

What Is Interior Design?

Interior design is a profession that calls for creativity to shape spaces that meet human needs and enrich people’s lives. Interior designers plan, design, create, invent, and construct spaces where people can live, work, study, play, and engage in various activities. The range, realm, and work scope of interior design are diverse in terms of countries or regions where the task takes place. In countries with rigid requirements for professional qualification, a relatively clearer work scope of interior design is observable; but in other contexts, the scope is somewhat loosely defined.

The confusion in defining the scope and roles of interior design is attributed to diverse nomenclature, such as interior decorator, interior designer, and interior architect (Whitehead, 2017). As one might imagine, the scope of the work of the interior decorator

concentrates on the ornamentation of rooms with artwork, accessories, fixtures and lighting; for an interior designer, the scope involves selecting finishes and fixtures for existing spaces, space planning, and renovation of existing space; and for an interior architect, the scope entails the allocation of new spaces with stronger interdependence of architecture, considering the site and other architectural elements.

The International Federation of Interior Architects/Designers (IFIs), the sole international federating body, has described the responsibilities of interior architects/designers as follows:

- (a) identify, research and creatively solve problems pertaining to the function and quality of the interior environment;
- (b) perform services relating to interior spaces including programming, design analysis, space planning, aesthetics and inspection of work on site, using specialized knowledge of interior construction, building systems and components, building regulations, equipment, materials and furnishings;
- (c) prepare schematics, drawings and documents relating to the design of interior space in order to enhance the quality of life and protect the health, safety, welfare and environment of the public. (IFI, n.d.)

The descriptions above deliver the essential aspects of interior design; it is multifaceted because design activity requires understanding complex aspects of human needs—physical, mental, and emotional. It requires knowledge in diverse areas—design, construction, and systems (e.g., building systems, materials, finishes, and furnishings) as well as standards and regulations. The scope has changed from more decorative aspects in the past to a more holistic approach, including programming and space analysis and planning. On the practice side, interior designers traditionally handled the enhancement, embellishment, and decoration of space; and architects handled allocation of spaces, involving structural and mechanical aspects; but in the 21st century the work scope of interior design has become more collaborative.

In the following sections, we will discuss how interior space is shaped, the qualities of creative interior spaces, strategies for the creative design process, and prerequisites of creative interior designers.

Shaping Interior Spaces

The main goal of designing an interior environment is to support intended activities and to enrich human experiences. Behavioral neuroscientists believe that environment plays an important role in human behavior. The holistic composition of spatial configuration, the vigilant curation of the interlacing of the paths of people's movement, interrelationships among thresholds to rooms, and the orchestration of furniture and other interior components can elegantly foster social interaction among end users. The strategically handled adjacencies among the spatial programs in a workplace environment can promote workplace creativity. In fact, the physical work environment is known to indirectly impact workplace creativity by contributing two significant sociopsychological conditions: dynamism and freedom (Vithayathawornwong et al., 2003). Artistically applied visual components in a themed restaurant captivate the guests. A low ceiling can be strategically put before an open airy space to accentuate the feeling of release after a person progresses through the compressed space. A unique way of treating patterns, surface materials, colors, furnishings, and decorative elements can create deeper meaning and appealing expression.

The way humans shape the interior environment has evolved along with the development and advancement of human history, as shown in the ways humans have responded to social, economic, cultural, and technological transformation. Human aspiration for aesthetics has changed, reflecting such transformation; and the ways to achieve an aesthetic level have also evolved according to changing expectations. Once the first successful design becomes an exemplar for other designers, who follow the key innovative aspects of the design principles, a unique attribute becomes a leading trend. After a while each of these trends becomes a standard form, losing its momentous significance, excitement, mystery, and surprise that such design once displayed. It becomes an ordinary space, and people seek more inventive approaches fresh to the eyes.

In art history, Kubler (1962) defined the first inventive leading example as the “prime object”: This idea applies to interior design practice as well. Prime interior space design is often featured in design magazines and valued by many designers and the general public because of the unique way of solving problems and achieving aesthetic goals. As time passes, many designers may take the same or similar approach; but the key aspects used for the prime interior space design undergo an evolutionary process, producing new developed forms or experiencing rebirth and combination with other contemporary features or becoming forgotten and remembered only in history.

“Creative” Interior Design: Product and Artifact

What attributes define creative interior design? Researchers of creativity typically characterize creative design as both original and useful. Because each profession has its own perspective on creativity, a defined domain-specific set of criteria for evaluation and judgment of creativity is necessary. In a broader sense, in terms of the applicability of the general characteristics of creativity to the field of interior design, appropriate solutions are sought to meet various spatial needs with imagination and exploration to satisfy the client's aesthetic expectations. Because of the high level of complexity that interior design entails, however, various aspects must be discussed in a more comprehensive way in order to explain the unique attributes of domain-specific creativity in interior design.

Unconventional Approach to Problem-Solving

Interior designers engage in acts of solving diverse space-related problems based on an understanding of the varying needs of a client and users. Many researchers have argued that creative activity is, in one way or another, a form of problem solving. Creative problem solving involves a unique approach to meeting all the functional requirements in an exclusive as opposed to a conventional way. For instance, after a few years a restaurant owner may realize that he has lost customers because his restaurant space does not really express its own identity and the space is generally too noisy. Numerous solutions could be used to address these two problems. Simple solutions, such as adding typical acoustic tiles on the surface of the existing ceiling and changing the name of the restaurant, would not be perceived as creative solutions. Instead, a more creative approach may entail redesigning the ceiling with fire-rated sound-absorbing material with color and shape specifically designed to express the distinct characteristics and identity of the restaurant as well as to absorb sound effectively. A design solution that is unique and simultaneously fulfills both the functional requirement and aesthetic expectations is considered a creative design: e.g., interior Designer Eva Maddox transformed the atrium space in George and Helen Smith Athletics Museum into a five-story high spatial museum by incorporating graphic murals, digital displays, and suspended glass vitrines for trophies. Viewers are able to immerse themselves in the three-dimensional exhibit and experience the feeling of becoming part of the story (see Fig. 1).

As new challenges arise in an increasingly complex world, interior designers must deal with numerous problems at once. Unknown future problems may arise as a result of the transformation of dynamic social relationships among users, the reshaping of individuals' lifestyles, the evolution of materials and technology, and modifications in environmental needs. Regardless of the types of challenges, aspects of creative problem solving are likely to fall into the following categories from the macro to microlevel: (a) thoughtful spatial allocation: organization of zones, spaces, or rooms (e.g., a creative arrangement of rooms that encourages social interaction); (b) careful treatment of space-defining elements (e.g., perforated screen partitions in a restaurant defining each space without losing visual connectivity); (c) attentive planning of the circulation pattern (e.g., a carefully designed circulation path to foster informal encounters and unexpected innovation among employees); (d) strategic use of furniture and configuration of interior elements (e.g., a uniquely shaped reception desk that could also accommodate an ADA counter); (e) innovative use of materials, resources, and technology (e.g., the use of smart glass for a conference room to control visual privacy); and (f) artful use of texture, color, and light (e.g., the use of a certain color and texture for particular psychological comfort and well-being). These are not ontological categories but can be used as lenses through which to view aspects of creative interior design in various contexts.

Enriched Aesthetic Experience

Creative interior designers achieve novel aesthetics suited to a specific space by considering the project type, cultural and social context, and needs of the client. The style of aesthetics can be diverse according to the purpose of the space and the designer's intention. For example, appropriate aesthetics differ per bar, sports center, hospital patient room, and spa. For a popular pub near a college town, exciting and invigorating aesthetics may work well, but for a spa at an assisted living complex, more calming and relaxing aesthetics will likely work better.



Figure 1 George and Helen Smith Athletics Museum designed by Eva Maddox. Photo credit: Joori Suh.

The definition of *aesthetics* has two parts: “(a) a set of principles concerned with the nature and appreciation of beauty; and (b) the branch of philosophy which deals with questions of beauty and artistic taste” (Aesthetics, 2019). The first definition relates to the psychological aspects of aesthetics—the principle of aesthetics that results in emotionally pleasing responses. The second denotes aesthetics as a discipline. Observing design studio conversation between instructor and students, Cho (2011) found that discussions of aesthetics occupied two primary realms: the visual and the spatial. That is, the majority of discussions on the aesthetics of interior design involve the visual aspects of a space, including color, finishes, and shape of the space; or elaboration on the spatial experience, including spatial quality, organization, or sequence of spaces. Aesthetics in creative interior design reflects the essential quality of the space and involves more bodily and sensory experience appealing to sight, sound, smell, touch, and taste. According to Whitehead (2017) atmosphere is the pervading tone or mood of a place and the “sense that the interior can convey an impression of its inhabitants” (p. 16). Juhani Pallasmaa (1996) criticized the tendency in modern architecture to be overly oriented to the sense of sight, arguing for more inclusion of other sensory experience. Altogether the finishes, sounds, and aromas contribute to the creation of a unique atmosphere that one cannot imagine in other places, resulting in symbolic aesthetics for the individual. For example, architect Peter Zumthor designed a spa in Switzerland called Therme Vals, renowned for capturing a magical mood with rich sensory and poetic experience.

The aesthetic experience is the result of the interaction between the atmosphere of the physical space itself and the emotional experience of people. Thus, the familiarity and expertise of people resulting from education, prior experience, and cultural or other aspects of individual backgrounds will impact the aesthetic experience. In addition, the perception of aesthetics held by designers and laypersons could differ. Thus, in the creation of interior space, designers anticipate considering laypersons’ perspectives and advocate aesthetics for the public.

Symbolic Meaning and Value

Typically, interior design demands (a) an organizational concept to meet programmatic requirements and (b) a character concept to satisfy thematic or stylistic needs (Rengel, 2014). The character concept of the design often becomes a metaphor that arouses associated meaning and emotion. Creating such metaphors in interior space plays an important role in making the space unique, memorable, and experientially engaging for the users. In her design narrative framework Ganoe (1999) included innovation as one of the criteria that define the significance of design meaning and purpose. Innovation here involves the quality of design that expresses and creates an original meaning. Many creative interior designs exude power, which is usually the result of the additional meticulous and artful expression of significant meaning or the philosophy of a designer. The expression could be applied to the fine detail of the interior elements, materials, colors, forms, or calligraphy to convey a certain impression as a powerful message. Meaning making is evident in the history of interior design as a form of iconographic images or symbols added to significant spaces.

Introduced by Swiss theoretician Ferdinand de Saussure (1875–1913), semiotics applies to interior design in that the particular design concept as *signifié* (signified) is expressed through *signifiant* (signifier), a total image created by interior design elements. Many creative contemporary interior design examples could be explained based on their imbedded symbolic meaning. For example, at the IBM Watson Center, the CNC-milled aluminum plate wall pattern was designed to reflect big data pertaining to the mobile sales of the company as a spatial narrative. Functionally, the perforation in the metal partition works as a layer to emit light behind the perforated plate. Instead of using a simple lattice pattern, the design firm Synthesis Design + Architecture intentionally used a data-driven method so that people can relate the decorative pattern with the implied meaning.

Another example is Kia Beat 360, a multipurpose brand experience center located in Seoul, Korea (See Figure 2). Constructed with a series of connected modular elements, the parametrically fabricated structure functions as a divider between spaces, and its dynamic three-dimensional patterns allow the structure to elegantly and symbolically deliver the brand philosophy: “a different beat” (Kia Beat 360, 2018). French designer Phillipe Starck often uses metaphorical elements to arouse wonder and imagination.

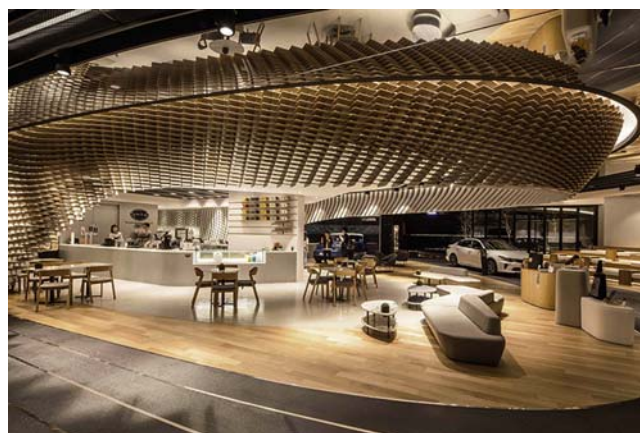


Figure 2 KIA Beat 360 designed by Ca Plan. Photo credit: Ca Plan Co.

The metaphorical materials that he uses are common and almost trivial, such as pool tubes, lighting, and mirrors; however, the extraordinary way he integrates these materials into his interior design raises powerful emotions in viewers. As he explained, these elements are used to introduce “fertile surprises” into the “mental game” he creates (Stark, 2013).

Inventive and Explorative Attribute

Humans have strived to make space more convenient and comfortable to accommodate various activities in interior space. Interior designers have solved complex problems by employing available resources. We see the quality of creativity when a particular interior design displays an inventive approach to solving problems by actively devising unconventional ways of using known materials or resources; by integrating new materials using new technology; or by bringing new insights into the known making process.

Humans have searched for mystery and curiosity in their lives, and this desire has pushed interior designers to surpass conventional wisdom and seek something new. Creative exploration using the computational making process, such as parametric design and 3D scanning and printing, revolutionized the way designers approach spatial design and create interior design components. Unconventional ideas and design can be generated by the computational generative process, fostering the production of unexpected and extraordinary forms. This inventive approach typically involves the creative fabrication process and integration of inventive assembly methods instead of simple application of materials, colors, and finishes. The inventive quality can also be achieved by integrating new insights into existing technology or construction techniques. Warren Platner’s creative use of fan vaulting-inspired ceiling design at the American Restaurant in Crown Center, Kansas City, was an exemplar (see Fig. 3). Platner used the vaulted ceilings in Gothic architecture as his inspiration and exercised his modern interpretation of a historic element to manipulate it with a modern flair.

The four qualities of creative interior design introduced above are not mutually exclusive; instead, they contribute holistically to making the interior space creative.

“Creative” Interior Design Process

The process of interior design is typically defined as follows: (a) problem definition (i.e., through research and analysis of clients, sites, and context), (b) concept development (i.e., through analysis and precedent studies); (c) schematic design; and (d) design development. In practice, it advances further to construction documentation, implementation of space, and Post Occupancy Evaluation (POE).

Many creativity researchers have strived to identify effective ways to engender creative ideas. Unlike fine art, which ultimately pursues the embodiment of the artist’s imagination, interior design begins with a clear understanding of the problems and issues; the cultural, social, and geographical context; and the client. Appropriate knowledge of human, space, and a clear contextual understanding precede creative interior design. Thus, the creative interior design process begins with the research phase, during which an interior designer gathers information about the basic guidelines of the project type, significant contextual data that might influence



Figure 3 American Restaurant in Crown Center designed by Warren Platner. Photo credit: McGraw-Hill Education.

the design, social dynamics among individual users, sociocultural specifics of the client and the future users of the space, and a precedent study of current practice. In order to link the information gathered in this phase with creative ideation, the designer should be cautious and use the information as resources but not for direct inspiration.

Generative Approach to Ideation

The design process entails a “constant iteration of analysis, synthesis and evaluation processes between the two notional design ‘spaces’—problem space and solution space” (Dorst and Cross, 2001, p. 434). By expanding the solution space, which is the number of potential answers to the problem, designers are not limited to an ordinary formula. The creative iteration process that leads to expanded solution space can be initiated from the precedent study, the goal of which is to understand the convention in order to explore more advanced or new ways of solving similar problems; however, in image-based precedent study, if not conducted properly, often causes design fixation (Jansson and Smith, 1991). The critical point is to understand the design as a collective whole: When collecting precedent examples, organizing them under certain categories or archetypes, a designer can recognize the (a) core principle that was applied to many cases and (b) parameters that distinguish each case from the others (Suh, 2017).

For instance, a designer who finds a series of interior design examples with a thick wall with several alcoves may name such a phenomenon “wall nook” and define this archetype as “an alcove space created inside a thick wall” as a core principle. The designer may also recognize that the nook can be shaped variously (deep, shallow, round, rectangular, bottom of the wall, high up in the wall, etc.) to support various activities (sleep, study, gather, eat, or relax). These variations become parameters. Cornell’s intypes (interior archetypes), established by Jennings (2007), are useful for understanding contemporary practices in interior design and the generative potentials imbedded in each archetype. Understanding design based on this core principle + parameter structure encourages the designer to take an active generative approach in the ideation process, thereby expanding solution space.

Once the precedent study and information gathering phase have been sufficiently performed, the designer takes the step toward ideation. Without the appropriate process of ideation, in most cases the proposed design becomes another conventional variation of the precedent example, falling short of innovation. Scholars have introduced design heuristics to facilitate designers’ creativity in the ideation process. Derived from Greek *heuriskein* (meaning to find out, to discover), a heuristic method is a technique used to aid problem-solving and the discovery process by incorporating various exploratory strategies. Yilmaz et al. (2016) suggested design heuristics to revamp fixed ideas by using 77 different methods to alter, modify, adjust, or reshape the initial idea: e.g., change direction of access; change geometry; layer; and repeat. Once modified for suitability to the domain, such design heuristics can be applied to interior design to foster expanding the solution space. Von Oech’s (1992) Creative Whack Pack consists of 64 creative thinking strategies that push the designer to think outside the box: e.g., drop an assumption, make a metaphor, look to nature, and simplify. Some of them encourage the designer to change attitude toward the design process, and others suggest breaking the conventional way of thinking and inspire the designer to try other strategies.

Combinational Method

Many researchers emphasize the importance of a certain structured process of ideation. Among these, the benefit of the combinational method of ideation is often discussed to discover what to combine and how to combine in order to enhance the creative generation process. The combinational method values what the whole can create by combining more than two known concepts, ideas, or design components. In interior design, the combinational process can be employed at the early conceptual level of ideation and also during the design process.

The basic combinational ideation structure suggests that a designer first initiates various primary ideas to create a pool of sources and then generate more complex new ideas by combining two or more primary ideas from the pool (Suh and Cho, 2018). The combinational process can be applied to the (a) form-making process by combining two-dimensional and three-dimensional design components from one scheme or from several schemes and (b) problem solving-focused practice by integrating multiple solution concepts, perspectives from various disciplines, a variety of theoretical approaches, or new technology. For instance, a stairitorium is a grandiose stair space where people can walk up and down as well as sit, relax, study, and gather as a small or large group for various activities. By combining the functions of vertical transition and casual gathering, a stairitorium serves a variety of activities and maximizes the real estate value of the space.

Collaboration

The practice of interior design requires collaboration among peer interior designers as well as other relevant stakeholders, including architects, lighting designer, furniture designer, structural engineers, digital fabrication experts, builders, material specialists, and clients. The design discipline has been traditionally considered one in which sole authorship “by a creative individual in isolation [instead of] a group of individuals” is valued (Constantino and Cho, 2015), so designers often hesitate to collaborate because of the assumption that the authorship of the design is lost and they may be unable to use their creativity sufficiently for the sake of teamwork. Many researchers, however, have demonstrated that collaboration actually enhances creative thinking and outcomes and can leverage creativity because it compensates for one’s weakness and creates a synergy among members; furthermore, it can produce outcomes that are more than the sum of the parts.

When we look at students' collaboration processes, this tendency is obvious. One student is good at finding relevant resources and information; another is strong in generating exciting design concepts and strategies for a project, and yet another is proficient in expressing ideas and visualizing. Students often remark about the benefits of collaboration in brainstorming because they can dialogue about ideas and develop them, promoting numerous perspectives on projects. For such reasons, educators try to bring more collaborative practices into education so students can experience the benefit of collaboration for creative outcomes.

Kvan (2000) categorized three types of team work—coordination, cooperation, and collaboration—according to degree of shared authorship, resources, and compensation. Collaboration is the most advanced type in which participants create something that cannot be made as individuals. Constantino and Cho (2015) identified four strategies that can calibrate collaboration for creative outcomes: "(a) removed group-member hierarchy, (b) shared authorship, (c) use of visual communication techniques, and (d) design heuristic implementation" (p. 1). In fact, the necessity and motivation for collaboration exist in the contemporary design field because more complex tasks require creative input and feedback from specialized experts. Cross-cultural and transdisciplinary projects necessitate collaboration involving expertise, resources, and technologies. One way to cope with the challenges of the uncertainty of a rapidly changing society will be the collective team creativity which results from collaboration.

Divergent–Convergent Thinking

Design is an open-ended, vague, and ill-structured problem-solving process because it has no single correct answer and the solutions are not completely determined by given information. The creative interior design process entails both divergent and convergent thinking. Divergent thinking involves the ability to generate diverse, new, and original solutions to a given problem, whereas convergent thinking refers to the ability to suggest a single solution to a problem using logic and conventional rules (Guilford, 1959). Divergent thinking involves the expansion of thought and thinking without boundaries and from various perspectives. The characteristics of divergent thinking include flexibility, fluency (generating many ideas), and originality.

Also necessary for creative solutions, convergent thinking requires the capacity to blend various ideas into one best solution by summarizing, synthesizing, and decision-making in order to move into the next stage. Traditionally, convergent thinking has been perceived as the opposite of creativity, but recent researchers have found some evidence that creativity is a dual process involving both (Lazar, 2018). If one depends too much on divergent thinking, she or he may have difficulty in decision making and moving to the next stage; in contrast, if one lacks divergent thinking, she or he will likely have difficulty generating various ideas and maintain a single idea. According to Lazar (2018), a series of recent neuroscience studies using fMRI revealed that brain activities during the design process occur in multiple areas of neural networks and active interactions between hemispheres, implying that design creativity is unique among other types of creativity and entails both divergent and convergent thinking.

Prerequisites of "Creative" Interior Designers: Person

Then what are prerequisites for creative interior designers? Some people are naturally gifted with creativity, but creativity can be nurtured to a certain degree. Expertise and knowledge in the field are prerequisites to become creative interior designers, and these can be obtained through education. In addition, cognition and thinking style are malleable and can be acquired through training. The following offers a discussion of the four qualities prerequisite to the creative interior designer.

Expertise, Knowledge, Skill Set

Creativity involves the mental process of domain-relevant skills, including "memory for factual knowledge, technical proficiency, and special talent in the domain" (Amabile, 1994, p. 319). Knowledge of recent design trends, technology, system and structure, human behavior, regulations, and visual perception are all necessary for an interior designer. When one's expertise and knowledge accumulate to become a repository, the designer can easily extract appropriate information and resources. The repository can be explicit, resembling digital storage or actual file folders; but it could also exist inside the designer's head. Polanyi (1958) called it "tacit knowledge" that is difficult to describe or transfer to another person but significant in developing expertise. The content of the repository could be diverse, such as information on programming (e.g., needed types and sizes of rooms); it can be a gut feeling, intuition, or forecasting ability to determine what does or does not work well. Researchers found that more experienced designers have richer repositories and easily use them and generate ideas more effortlessly than novice designers. Although the amount of knowledge does not always correlate with creative outcomes, it is a necessity for creative thinking.

Visual communication skills—the ability to read, interpret, and produce drawing conventions—are also essential for creative interior design. Prerequisites for interior designers include understanding interior design information in space, communicating one's ideas with other designers or clients, and testing one's own idea for design development. In addition, knowledge of and the skills needed to use digital tools are essential in the contemporary design world. Examples of such tools include Computer Aided Design (CAD), Building Information Modeling (REVIT), Rhino, SketchUP, Maya and 3D Max.

Flexible, Adaptive, and Open-Mindedness

Flexible mind, the attitude to adapt new, different, and changing requirements, resembles the “adaptable mind” (Meneely and Portillo, 2005). Open-mindedness is one’s attitude in approaching design without prejudice or bias. Without flexibility, one is likely to hold a certain idea, prior knowledge, or past experience without trying other approaches or methods. The Torrance Test of Creative Thinking (TTCT), one of the most reliable tools to measure adult creative potential, is based on divergent thinking theory. It includes five components as indicators of creativity; flexibility (open-mindedness) is one of them along with fluency, originality, elaboration, and abstract thinking.

To illustrate, imagine that an interior designer has recently accepted a project to design a coworking space and that she had successfully completed the design of another such space five years earlier. If her thought is fixed on the past successful experience, she may approach the new project similarly, applying comparable space planning, finishes, and materials. If so, the new project may not be so successful and creative because a change may have occurred in technology, the generational character of the users, or work style; the work flow in the new coworking space may also differ. Adaptability to new ideas, concepts, and resources that fit the new project as well as up-to-date knowledge is essential. A successful idea for one coworking space may not be successful for another space; the idea may be already too popular, so no more novelty is elicited. Creative design entails knowledge and expertise, but it also necessitates flexibility, adaptability, and open-mindedness to approach the task with a new and fresh perspective.

Spatial Visualization

Spatial ability is the ability to imagine, manipulate, and produce spatial information. In interior design, the majority of information for communication is either in 2D or 3D format, such as orthogonal drawings (e.g., plan, elevation, and section), perspective, axonometric, renderings, and sketches. Although the subconstructs of spatial ability are diverse among researchers, it is typically known to consist of three subconstructs: mental rotation, spatial perception, and spatial visualization. Among the three, spatial visualization, particularly 2D to 3D visualization, has been revealed to predict the ability to produce original design (Cho and Suh, 2019). Spatial visualization involves “complicated, multistep manipulations of spatially presented information” (Linn and Petersen, 1985, p. 1484) and is most complex among the three subconstructs of spatial ability. Without spatial visualization, designers have difficulty visualizing and imagining objects spatially. Spatial visualization can be categorized into the following two levels: the fundamental level (to read and understand spatial information) and the advanced level (to imagine, transform, infer, and generate spatial information). To illustrate, the former requires knowledge of technical drawings and graphic conventions, such as knowledge of what thick lines and dotted lines mean in floor plans and section drawings; however, understanding only the meaning of such lines in drawing is insufficient in creative design. Designers must be able to imagine what the lines mean spatially and to infer the spatial relations and even the atmosphere created in the space. Designers create three-dimensional habitable spaces using drawings or sketches or by modeling digitally and manually before actually constructing them. Virtual Reality or Augmented Reality technologies can aid designer’s visualization along with other drawing and rendering software programs.

Intrinsic Motivation: Interest in Human Well-Being

Researchers have determined that along with domain-relevant skills and creativity-relevant skills, creative persons have strong intrinsic motivation, the most important factor in creativity among the three (Amabile, 1994). Intrinsic motivation is “the motivation to engage in a task primarily for the sake of the task engagement—because the activity itself is interesting, enjoyable, or personally challenging to the individual” (p. 320). It differs from extrinsic motivation, such as expectation of rewards or the desire to meet deadlines.

The intrinsic motivation of creative interior designers could be a deeper and genuine interest in human beings and the desire to create space elevating people’s quality of life. Interior design educators have emphasized “human-centered design” through profound understanding of human experience, behavior, and performance. Of particular importance is that interior designers create spaces where humans engage in everyday activities because people spend more than 87% of their lives indoors (Klepeis et al., 2001). Interior designers are advocates for public health, safety, and well-being.

Kijong Jeon, an interior designer and a professor at California State University, Chico, designed a multisensory environment for the improvement of the mood and behavior of cognitively impaired individuals with autism, the Community Opportunity for Vocational Experience (COVE) in Paradise, California (see Fig. 4). COVE is considered one of the pioneering works of design as therapy. He argued that design can serve as a passive therapeutic solution. At COVE, “fiber optic lighting, mesmerizing projections, undulating surfaces, and biomorphic furniture” (Design as Therapy, 2016) along with the sound of dropping water in a fountain and images projected on a multilayered wall create a both soothing and stimulating environment that encourages exploration of the space. Families of autism clients and administrators of the COVE reported many cases of positive changes of behavior (McGuire, 2009). In terms of his motivation, Jeon stated, “My work is completely life-affirming for me. It fills my heart. I love it” (<http://www.kijongjeon.com/cove.html>).

Creative interior designers require interest in the relationship between the characteristics of space and human response—the character of space that people like to approach or avoid and that people can concentrate or collaborate better and the reason for such reactions. The central idea is that the design decision should be based on a profound understanding of human needs. The



Figure 4 Multisensory environment for COVE designed by Kijeong Jeon. Photo credit: Kijeong Jeon.

moral, ethical, and wholehearted interest in human well-being and health appears at the summit of intrinsic motivation for creative interior designers.

Conclusion

Thus far we have discussed the multifaceted relationship between interior design and creativity and proposed a framework to understand domain-specific creativity in the field of interior design (see Fig. 5). We expect that this chapter will open a new discussion of the topic and add another perspective to creativity research.

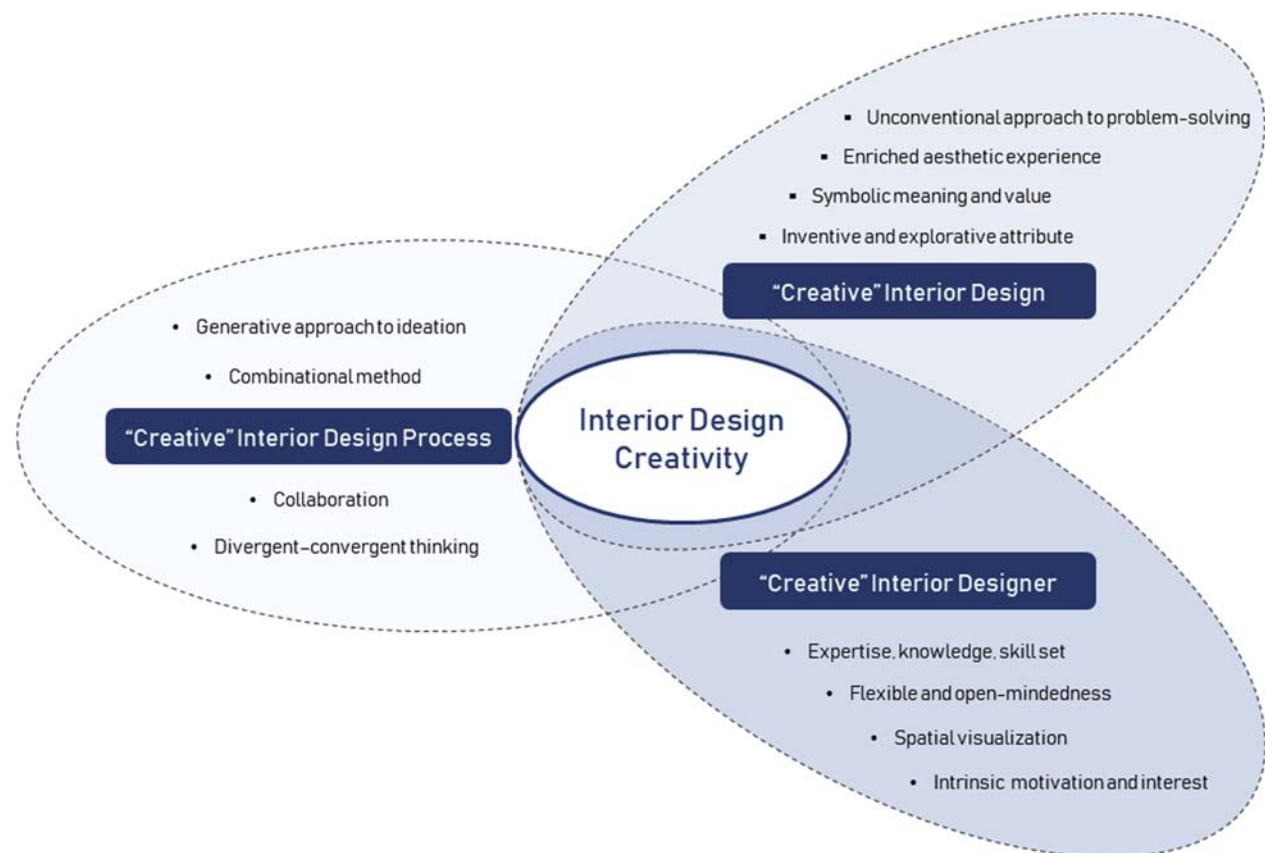


Figure 5 Diagram for proposed framework for domain specific creativity of interior design.

Creativity has been the driving force behind the development and advancement of interior design. In the 21st century, we face an increasing number of complex issues and as yet unknown problems. These challenges include various environmental issues, such as global warming, resource depletion, air pollution, energy saving, and sustainability; social issues, such as changes in the family structure, lifestyle, generation gap, value conflicts, marginalization, poverty, and inequity; and technological issues, such as rapidly developing and changing technologies, robotization, and artificial intelligence. This highlights the importance of a strategic approach and human creativity that are more vital now than in any other time in history. These challenges eagerly await creative interior designers' creative mind and solutions.

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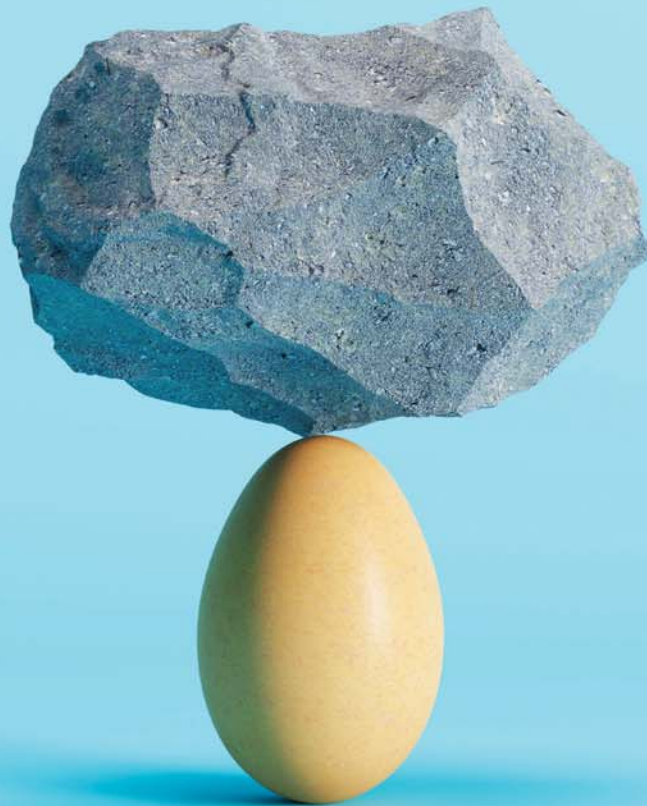
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Encyclopedia of **Creativity**

Edition

3



Volume

2

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PREFACE

The first two editions of *The Encyclopedia of Creativity* were enormously successful. They provided easily-accessible and trustworthy information about creativity and various topics related to creativity, such as innovation. The second edition, published in 2011, was named a 2012 *Outstanding Academic Title* by the American Library Association's Choice publication. The 3rd edition was inspired by the vast amount of new research about creativity. The field is expanding very rapidly. Much of this research is related to the increased complexity of each of our lives. Creativity helps each of us deal with such complexity. It also helps businesses, schools, and other organizations as the demands placed on them move faster and becomes more urgent. In addition, creativity provides new answers to such difficult problems as climate change, limited resources, religious and territorial conflicts, and poverty. For these reasons the *Encyclopedia of Creativity* includes articles that describe the creativity of individuals as well as organizations.

The *Encyclopedia* captures the full range of approaches to creativity. Creativity research is being conducted throughout the world in many different disciplines, including psychology, arts and humanities, health sciences, education, and business. The global interest is reflected in the number of authors throughout the world who have contributed to this edition as well as the topics covered.

Some countries such as China, Korea, Singapore and New Zealand have made understanding, teaching, and encouraging creativity part of their national goals. Europe proclaimed 2009 the year of creativity. The leaders of these countries recognize that their primary natural resource is the ability of their citizens and organizations to develop new products and innovative concepts. As competition becomes more and more intense, the business community in the United States is finally accepting the concept that creativity can contribute directly to the bottom line. A poll of CEOs in the United States by IBM's Institute for Business Value indicated that creativity is the most important characteristic being sought in new executive hires. We have responded to the increased interest in the business community by including more entries on organizational creativity.

The *Encyclopedia of Creativity* is designed to inspire further recognition of the personal as well as professional benefits that accrue from encouraging creativity. We know, for example, that individuals who are more creative are healthier and more adaptive, and in some instances may even have a longer life expectancy. We also know that many innovations and ways of solving problems have already led to incredible benefits, such as cures for diseases, improved technologies, and higher living standards for billions of people.

If we want a more creative world, then we must construct an environment that allows creativity to flourish. This requires knowledge that crosses disciplines. The increased quantity and diversity of research continues for the most part to be focused on a specific area of interest. Most scientific research is still released only in academic journals. There is still not a broad cross-fertilization of knowledge that enhances the development of new ideas. One of the axioms in creativity research is that breakthroughs often occur when information or concepts from one field are applied to a different one. Darwin's theory of evolution was partially inspired by his reading Malthus' theory of population growth and Lyell on geological change. Jean Piaget, noted developmental psychologist, borrowed heavily from biology and epistemology. Freud used a medical model to understand the psyche. Our hope is that readers will roam outside their usual areas of interest in a search for new ways of thinking. The comprehensive nature of the encyclopedia offers readers the opportunity to find new perspectives, which we hope will suggest fresh insights about themselves, their work, and their place in the world.

In the first edition we stated that there was enough known about creativity that it could be integrated into every level of our educational system. Unfortunately "teaching to the test" has become more prevalent in the United States while arts programs have been all too often dropped. We are obviously losing a great deal of the creative potential on this planet by leaving so many of our children uneducated and unable to cope with the

problems they face. The Encyclopedia continues to place an emphasis on education and cognition. It is our hope that teachers at the elementary and high school level will learn about their own creativity and how to value and encourage students. It is not always an easy task, but it can help enhance and even save the lives of some creative students who are at risk.

There has been some progress. The increased recognition of the importance of creativity in education was exemplified by its inclusion as number 8 in the top 20 competencies for teachers by the American Psychological Association. A 2019 Gallup poll in the United States reported that “Eighty-seven percent of teachers and 77% of parents agree that teaching approaches that inspire creativity in the learning process have a bigger payoff for students.”

Improvement is also evident at the college and post-graduate levels where courses in creativity are taught in many schools throughout the country. There is still a tremendous need for degree earning programs and specializations in creativity. The Torrance Center at The University of Georgia, Saybrook University, Buffalo State, and Drexel University are among the schools that currently allow a specialization in creativity studies. We hope that soon there will be many more universities and professional schools which include courses and specialties in creativity studies.

Audience

This Encyclopedia was designed for use by students of creativity, as well as researchers, teachers, scientists, coaches and consultants, architects and designers, trainers, managers, actors, writers, directors, painters and other individuals in the creative arts, inventors, therapists and other professionals who utilize creativity in their work. Anyone who is interested in learning more about their own creativity and the creative process can benefit from the articles presented here. None of this implies that there are quick and easy self-help answers - individual creative growth requires work, time, serious thought and a commitment to deeper understanding of the process. Still, creativity can be fun and it adds to the quality of life. Creativity can help us experience the highest levels of involvement in work and play that ultimately leads to great joy. Readers are encouraged to follow their own interests and inclinations in exploring these volumes.

Topics and Contents

Creativity is often viewed as a syndrome or complex. This perspective is described in various contributions to this volume, as are the various processes that are thought to make up or contribute to creativity. Other entries focus on particular methods and disciplinary approaches. In fact, one significant difference between this edition and the last one is that of sections devoted to the neurosciences and to technology and creativity. In addition, this edition is organized as a kind of hybrid, with overarching topics, including the two just mentioned, but also with various articles subsumed under Measurement and Personality headings. Specific topics include the following:

- There are reviews of a number of domain-specific areas, such as acting, dance, expressive arts, film, food, music, religion, science, sports, theater, and writing.
- Creativity and education are examined in articles about thought processes, such as developmental trends in creative abilities and potentials, the enhancement of creativity, intelligence, knowledge, play, prodigies, programs and courses, talent and teaching creativity.
- Cognitive aspects of creativity can be investigated in articles about altered and transitional states, analogies, attention, cognitive style, divergent thinking, flow and optimal experience, metacognition, metaphors, problem-finding, problem-solving, and remote associates.
- Those interested in business and organizational creativity can view articles about advertising with art creative visuals, business/management, creativity coaching, creativity exercises, entrepreneurship, group dynamics, innovation, leadership, organizational culture, organizational development, teams, and training, among others.
- Many articles examine the creative process across domains including areas such as discovery, emotion/affect, gender differences, incubation, inspiration, insight, novelty and paradigm shifts.

- The complex interrelationship between society and creativity is explicitly examined in articles about awards, conformity and conventionality, the creative sector and class of society, cultural diversity, the dark side of creativity, East vs. West, networking, social psychology, war, zeitgeist, and others.
- Personal and interpersonal creativity is discussed in articles relating to collaboration, family, life stages, mentors, networking, personal creativity and self-actualization.
- Because the encyclopedia focuses on scientific information about creativity, there are also articles that discuss concepts of creativity, definitions of creativity, expertise, longitudinal studies, researching art, artists and art audiences, research methods, phenomenology research and qualitative research.
- Articles which look at theoretical perspectives include behavioral approaches, chaos theory, componential models, economic perspectives, the evolving systems approach, the four P's of creativity, and implicit theories.
- The creative process is examined in contrarianism, climate for creativity, discovery, dreams, heuristics, invention, motivation/drive, multiple discovery, novelty, time and rewards.
- Mental and physical health and creativity are reviewed in mental health: affective disorders, health, mad genius controversy, schizophrenia and psychosis, stress, suicide, and transforming illness and visual art.
- Some subjects are grouped together in the Table of Contents. These clusters include the increasingly important Neurosciences and Technology, as well as Personality and Regional Creativity.

More than any other kind of book an encyclopedia is a collaborative effort. We thank our eminent panel of Subject Editors: Arthur Cropley, Vlad Glaveanu, Ning Hao, Maciej Karwowski, Aaron Kozbelt, Weihua Nui, Roni Reiter-Palmon, and Robert Weisberg.

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Figure 2 Flow

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Janusian, Homospatial, and Sep-Con Articulation Processes[☆]

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Creativity consists of the capacity or state of bringing into being entities that are both new and valuable. Three cognitive functions responsible for creative constructions and effects are the janusian, homospatial, and sep-con articulation processes. During the course of creative activity, these processes operate both independently and in conjunction with each other. Dynamic interactions within and among the three processes produce emergent creative integration.

Empirical Studies

The creative cognitive processes were discovered through long term empirical investigations consisting primarily of extensive semi-structured research interview procedures (Int = verbatim quotations used) with consensually recognized highly creative achievers in the arts and sciences. Subjects have been, in literature: Nobel laureates (IntNL), Pulitzer (IntP) and other notable literary prizewinners; in science: Nobel laureates in physics, chemistry, and medicine or physiology (IntNLS) in the United States and Europe. Interview procedures were carried out over the course of the subjects' both long and short term creative projects and consisted of detailed objective examination of psychological processes in ongoing work and, where appropriate, past creative breakthroughs. Experimental assessments, as reported more extensively below, were also done with these and other creative subjects and non-creative controls (Rothenberg 1983, 1988b). Comparison control research interviews, carried out in the same semi-structured manner as with the creative subjects, were performed with less or non-creative matching cohort controls.

Documented accounts of breakthroughs and other creative productions of outstanding creators of the past were also systematically analyzed. The large body of evidence collected indicates that the three conscious and intentional processes, janusian, homospatial, and sep-con articulation, are used for creative work and thought in literature, art and science and, by extension, in various degrees in fields such as business, education, politics, sports as well as general creative problem solving and other everyday creative activities.

[☆] *Change History:* August 2019. Albert Rothenberg updated the text throughout the article.

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Janusian Process

The janusian process, most commonly operative in the early or inspiration phase of creative production, consists of actively conceiving multiple opposites or antitheses simultaneously. The term, based on the multifaced (variously possessing 2, 4, or 6 faces) Roman god Janus looking always in diametrically opposed directions, denotes conscious conceptualization during the creative process of simultaneously co-existing and operative opposite or antithetical ideas, propositions, or actions. Although seemingly illogical and self-contradictory, creators construct these conceptualizations in rational states of mind in order to produce creative effects. In art and literature these are responsible for early conceptions of plot, character, metaphor, organization, and design; in music for compositional and melodic construction; in science for creative breakthroughs, theorizing, and experiments. Depending on the level of development of a creative product, the janusian process also operates at later critical junctures and with practical solutions in a wide variety of fields.

Simultaneity of the multiple opposites or antitheses is a cardinal feature of the janusian process. Creators conceive firmly held propositions about the laws of nature, the functioning of individuals and groups, or the aesthetic and compositional properties of visual and sound patterns as simultaneously true and valid and not-true and invalid. Or, both opposite and antithetical propositions are entertained as concurrently operative. A person running is both in motion and not in motion at the same time, a chemical is both boiling and freezing, or kindness and sadism operate simultaneously. Previously held beliefs or laws are still considered valid but opposite or antithetical beliefs and laws are formulated as equally operative or valid as well.

These formulations within the janusian process are waystations to creative effects and outcomes. They are interacted and joined with other cognitive and affective developments to produce new and valuable products. Homospatial and sep-con articulation particularly operate as later unifying processes. Analogical, dialectic, inductive and deductive reasoning are applied concomitantly in the development of theories, inventions, and artworks.

The janusian process initially disrupts pre-existing contexts and conceptions. Highly surprising, even incredible and inconceivable, are propositions that the contradiction or opposite of well-grounded fact, theory, or actuality is simultaneously valid. Previously held ideas and systems of ideas are split apart and broken, even essentially destroyed. This disruption provides for the development of something new.

Janusian Process in Science

While working on an essay for the Yearbook of Radioactivity and Electronics in 1907, Albert Einstein had what he called “the happiest thought of my life.” This happy thought was the key to one of the most far-reaching scientific breakthroughs of the 20th and subsequent century: the general theory of relativity. The circumstances producing it were revealed in a document by Einstein himself—unpublished during his lifetime—and entitled by him, “Fundamental Ideas and Methods of Relativity Theory, Presented in Their Development.” (Einstein and ca, 1919)

Einstein had already developed the special theory of relativity, which holds that since the speed of light is constant for all frames of reference, perceptions of time and motion depend upon the relative position of the observer. He had been forced to postulate the theory, he said, to explain the seeming contradictions in electromagnetic phenomena: “[that] one is dealing here with two fundamentally different cases was, for me, unbearable.” [translations, Holton, 1973]

He felt strongly that he had to come up with a new and meaningful solution. For many years, he struggled to modify Newton’s classical theory of gravitation so that it could be encompassed within a broad relativity principle, but he lacked a specific physical basis for bringing together the seemingly different or antithetical choices of Newton’s theory and his own special theory.

All at once, Albert Einstein described, he conceived “his happiest thought”. It was: “For an observer in free fall from the roof of a house, there exists, during his fall, no gravitational field ... in his immediate vicinity. If the observer releases any objects, they will remain, relative to him, in a state of rest. The [falling] observer is therefore justified in considering his state as one of ‘rest.’”

Development of the general theory itself was highly complex, but the specific structure of the key step is clear. Einstein had consciously formulated the simultaneously antithetical construct that a person falling from the roof of a house was both in motion and at rest at the same time.

In physicist Niels Bohr’s first written formulation of his in-process theory of complementarity, the theory that has been a foundation for modern quantum physics, he stated that wave or else particle states of light and electrons, widely believed at the time to be completely conflicting alternatives, involved “no question of a choice between two different concepts but rather of the description of two complementary sides of the same phenomenon.” He then went on to formulate the full-blown complementarity theory, stated as follows: two descriptions or sets of concepts, though mutually exclusive, are both necessary for an exhaustive description of the physical situation. His key initial formulation of the complementarity idea was a janusian process construct that both light and electrons were phenomena with simultaneously antithetical wave and particle aspects (Rothenberg, 1987).

In order to assess the phenomenon of scientific creativity empirically, I conducted a study of 45 Nobel laureates in physics, chemistry, and medicine or physiology located throughout the United States and Europe. This consisted primarily of detailed semi-structured interviews focused on the laureates’ creative scientific discoveries compared with the same procedures carried out with a control group of highly intelligent but non-demonstrably creative university faculty scientists. The following table shows the use of the janusian process consisting of conception of simultaneous opposites leading to outstanding creative discoveries of the Nobel laureate test subjects (Table 1).

Table 1 Janusian process^a

<i>Nobel laureate</i>	<i>Opposite factor</i>	<i>Opposite factor</i>	<i>Janusian conception</i>	<i>Discovery (discoveries)</i>
Edwin McMillan	Too high energy	Too low energy	Phase stability	Synchrotron
Pierre-Gilles deGennes	Hydrophilic	Hydrophobic	Janus grains	Surfactant interchange
Walter Gilbert	Bacterial genome	Human genome	Reverse evolution	RNA world hypothesis
Edward Purcell	Nuclear spins	Inverted nuclear spins	Negative temperature	Negative temperature
Charles townes	Positive temperature	Negative temperature	High energy source	Ammonia maser
Nicholas bloembergen	Negative temperature	Low temperature	Solid state energy	Solid state maser
Elias Corey	Putting together	Taking apart	Organic chemical construction	Retrosynthetic chemistry
Arthur Kornberg	Enzyme action on the substrate	Substrate action on the enzyme	DNA polymerase and synthesis	DNA synthesis
Joshua Lederberg	DNA input	DNA output	Genetic effect	Bacterial conjugation
Jean-Marie Lehn	Concave	Convex	Supramolecule	Supramolecular chemistry
	Pure mixture	Impure mixture	Instructed self recognition	Instructed mixture paradigm
Dudley H. Herschbach	Heterocycle Minimum	Opposite faced heterocycle Maximum	Janus molecule Nuclear change process	Janus molecule Dynamics of chemical elementary particles

^aThe first column designates the specific scientist; the second and third columns specify the opposite or antithetical factors; the third column designates the simultaneous opposites in the janusian conception; the fourth column indicates the creative scientific discovery. (Rothenberg, 2014)

Janusian Process in Literature, Art, and Music

(IntPP) Playwright Arthur Miller disclosed to me that he had come up with the specific idea for the play “Incident at Vichy” while traveling through Germany: “Driving on the autobahn, I suddenly felt amazed and overwhelmed at how beautiful Germany had become.” He conceived of writing a play that would simultaneously express the opposites of the beauty of modern Germany and Hitler’s destructiveness. “And then, I remembered a story I’d been told about a sacrifice made by an Austrian nobleman for a Jew in a Nazi official’s waiting room.” He developed the story of the political simultaneously antithetical sacrifice in his play.

Poet James Merrill had been home thinking about a past incident in which a horse had appeared at a lonely desert site, when it occurred to him, he told me, that horses are animals who “renounce their own kind in order to live our lives.” The idea that horses live human lives, that they are antithetically both beast and not-beast and human and not-human simultaneously, generated the poem, “In Monument Valley,” with the central image and theme of a happy and intense relationship between a young person and a horse, followed by a sad, resigned separation.

Artist Jackson Pollock’s early drawings and paintings were strongly based on the styles of Thomas Hart Benton, Diego Rivera, and Jose Clement Orosco. During the summer of 1939, when he was improving from alcoholism and mental illness, he created his first abstract expressionist paintings, becoming the so-called father of that style. These revolutionary artworks, he later explained to an art critic, were based on his conception of both obscuring an image and expressing it at the same time, a janusian process formulation.

In music, the writings of composers from early to more recent modern times have stipulated simultaneous oppositions regarding germinal aspects of their compositions. Renaissance composer Claudio Monteverdi described his method of producing slow and fast tempos simultaneously as a means of conveying the “contrary passions aroused by war, prayer, and death.” Modern composer and conductor Leonard Bernstein described the constant use of “contradictory forces, chromaticism and diatonicism, operating at the same time.” Composer Arnold Schoenberg conceived the simultaneous use of the opposites of consonance and dissonance in his musical creations and compositional instructions to disciples.

Homospatial Process

Mental representation of space is potentially more far reaching, extreme, and diverse than any physical actuality. The homospatial process responsible for many types of creative results involves mental representations that defy or go beyond objective or actual physical space. This process consists of actively conceiving two or more discrete entities occupying the same space or spatial location, a conception leading to the composition of new integrations and identities. In conscious mental space, creators superimpose, interpose or otherwise bring together shapes, patterns, written words, dimensions, distances, and other concrete entities. Subjectively, eyes closed or open, other physical receptors attentive or inattentive, the resulting mental image totally fills the conceptualized perceptual space. Any sensory modality may be involved: visual, auditory, tactile, kin-aesthetic, olfactory, and gustatory. The imaginary location may be considered to be the “mind’s eye”, “mind’s ear,” “mind’s taste,” etc.

Once the discrete entities in the homospatial process are consciously brought together, the mental conception is a rapid, fleeting one. In the creator's mind, the superimposed and interposed elements begin immediately to interact and produce new identities, including new ideas. These ideas constitute solutions to scientific and other problems, and in the arts they consist of created metaphors, plots, visual themes and constructions, musical passages, and other integrations.

Not a matter of simple combination, unconscious condensation, conceptual blending (Turner and Fauconnier, 1999) or of the discrete entities considered in stepwise or analytic fashion, the homospatial process involves unstably related entities that interact. Ordinarily used later than the janusian process but, as in an oxymoronic metaphor such as Hart Crane's "penniless rich palms" from his *Voyages II*, both processes may operate early and concurrently. Newness in the created results produced by the homospatial process begins with creators' breaching the physical percept that two or more discrete entities cannot in actuality occupy the same space. The valuable aspect emerges from rapid interactions among the superimposed and interposed elements.

Homospatial Process in Mathematics and Science

Mathematician Henri Poincaré described the mental conception of a coalescing and spatial superimposition of mathematical formulations which led to the discovery of a crucial aspect of his famous Fuchsian functions: "One night, I took some black coffee, contrary to my custom, and was unable to sleep. A host of ideas kept surging in my head; I could almost feel them jostling one another, until two of them coalesced, so to speak, to form a stable combination. When morning came, I had established the existence of one class of Fuchsian geometric series. I had only to verify the results, which only took a few hours."

(IntNLS) Chemist William Lipscomb described to me one of his Nobel Prize discoveries in boron chemistry as arising from a superimposed image of a hydrogen atom and a three center chemical bonding: "What I mean," he said, "by the superimposition ... this hydrogen comes over here [points to formula], and interchanges with this vacancy. I saw the previous three center bond there, and then it came loose and twisted around. I did that in my head and it became perfectly clear in the nuclear resonance study I published. I had the right structure."

Through the controlled empirical investigation of the creative discoveries of the science Nobel laureate subjects described earlier, the evidence on the following [Table 2](#) documents the use of the homospatial process in critical Nobel laureate scientific discoveries.

Homospatial Process in Literature, Art, and Music

The homospatial process is a prime factor in the production of poetic metaphors. An author experimental subject was, for instance, sitting at his desk writing a poem. To produce what was to be a central metaphor, "the branches were handles of

Table 2 Homospatial process^a

<i>Nobel laureate</i>	<i>Discrete entity</i>	<i>Discrete entity</i>	<i>Homospatial conception</i>	<i>Discovery</i>
Donald Glaser	Bathtub	Self taking pictures	Superimposed in orbit–superheating	Bubble chamber
Joshua Lederberg	Self	Bacterial cell	Superimposed self and cell	Bacterial conjugation
Owen Chamberlain	Velocity determining counter	Threshold determining counter	Superimposed– reduced material	Pickle barrel or secret weapon counter
Walter Gilbert	Roll of soiled toilet paper	DNA molecule	Continuous replication	Rolling circle model of genetic replication
Glenn Seaborg	Uranium	Rare earths	Subshell characteristics	Actinide concept of heavy elements
Dudley Herschbach	Energy transfer	Non-energy transfer	Wave node	Bond breaking and making
Walter Alvarez	Large meteor	Volcano eruption	Coal smoke cloud of darkness	Dinosaur extinction
Robert Huber	Fragments Symmetrical protein crystal	Asymmetrical protein crystal	Protein crystal structure in photosynthesis	Photosynthesis reaction Center
Pierre-Gilles deGennes	Snake	Noodle	Movement of clusters in a cell	Reptation
Joseph Murray	Grand piano	Old upright piano	Transfer location	Kidney transplant
Jean-Marie Lehn	Individual shapes or forms	Other individual shapes or forms	Superstructure	Chemical self-representation
William Lipscomb	Hydrogen atom	Three center bond	Chemical bondings	Borane structure
Norman Ramsey	Atoms in a box	Atoms in a tube	Atoms in a bottle	Hydrogen maser

^aThe first column specifies the Nobel scientist; the second and third columns indicate the specific discrete scientific entities; the third column designates the superimposition of the discrete entities in a homospatial conception; the fourth column specifies the creative scientific discovery. (Rothenberg, 2014)

stars," he had become attracted early to the words "handle" and "branch" because of their shared sound qualities—the assonance or shared "an" sound in the center of each—as well as the shared overall shapes of the wooden objects themselves. He then superimposed these words and their concrete images in his mind's eye; he brought them together because he felt they ought to be together. In the next fleeting moments, he asked himself when in reality they were the same, and also fleetingly experienced a vivid impression of the letter "a" overlapping in the two words. At that point the idea of stars was generated. Associational or analogical ideas of the country (or park) at night did not generate the metaphor; it was derived directly from the homospacial process conception that provided both the real scene and sound qualities that unified the words and their meanings.

In the creation of another type of metaphor, "the tarantula rays of the lamp spread across the conference room", this author in a detailed interview remembered thinking about writing a poem about a vacation in the tropics and, among the various thoughts and words that came to mind, he became interested in the sound similarity between the words "tarantula" and "lamp." He then actively superimposed mental images of the spider and a light source together, along with images of the letters in the words, because he felt these ought to be together. After mentally visualizing spidery light radiating out from the central source of the superimposed images, he thought of the metaphor, "tarantula rays of the lamp." Deciding to elaborate that fragment with a suggestive context, he next conceived of "conference room". Once the entire creation was constructed, he thought of overtones such as wars in the tropics, the idea of the slow crawl of a tarantula in contrast with the dazzling speed of light, and experiencing an awesome type of beauty, he was pleased. With both poetic creations, the author visualized a vague scene as well as found the answer in words. Later, he visualized more fully developed and vivid scenes similar to the ones experienced by a reader or audience, and he composed the metaphors as well as descriptions of the scenes into several poems. The fully visualized scenes did not, however, produce the metaphors, they mainly added to the poet's feeling of the aptness of his creation.

Sculptor Henry Moore indicated the crucial role of a homospacial process in the creation of sculptural works of art as follows: "This is what the sculptor must do. He must strive continually to think of, and use, form in its full spatial completeness. He gets the solid shape, as it were, inside his head—he thinks of it, whatever its size, as if he were holding it completely enclosed in the hollow of his hand. He mentally visualizes a complex form from all round itself; he knows while he looks at one side what the other side is like."

In music, auditory metaphors and new musical patterns and themes develop from homospacial process constructions. Ludwig van Beethoven described that "the underlying idea [of a musical work] rises ... grows, I hear and see the image in front of me from every angle, as if it had been cast." Robert Schumann said, regarding his composing process, "certain outlines amid all the sounds and tones ... form and condense into clear shapes."

Interaction Between Janusian and Homospacial Processes

(IntPP) James Merrill's previously described janusian formulation of a horse as both beast and human simultaneously for the poem, "In Monument Valley" was subsequently integrated into a particular central poetic metaphor by a homospacial process conception. A horse and human being were conceived as occupying the same space; that led to the construction of the following poetic image: "Stillnesses were swarming inward from the evening star/ Or outward from the buoyant sorrel mare/ Who moved as if not displeased by the weight upon her./ Meadows received us, heady with unseen lilac./ Brief, polyphonic lives abounded everywhere. With one accord we circled the small lake."

The resulting poetic image was neither a centaur, a mythical entity that is part human and part horse, nor was it some other mixture or combination of horse and man.

Experimental Evidence for Janusian and Homospacial Processes

A tendency or capacity for the use of the janusian process among proven and potentially creative persons, manifested by very rapid opposite responding on word association tasks, was experimentally identified (Rothenberg, 1978). Standard Kent-Rosanoff word association tests were individually administered to 22 Nobel laureates in science (physics, chemistry, medicine or physiology) and to rated-as-creative Yale College students (Rothenberg, 1983). Control groups consisted of matched but rated-less-creative students and high IQ psychiatric patients. Test instructions were to give the first word that came to mind in response to a standardized list of word stimuli and both speed and content of response were electronically recorded. Results signified, for the most creative subjects, formulation of simultaneous or virtually simultaneous opposite associations. The statistically significant highest number of extremely rapid opposite responses (averaging 1.1 to 1.2 seconds) were given by proven creative subjects, the Nobel laureate group, and the next highest by the rated-as-creative Yale students.

Experimental assessment of the creative action of the homospacial process, assessing the stimulus effects on art and literary metaphors of ten concrete representations of mental constructions consisting of a series of ten transilluminated superimposed component slide images, were carried out with artist and writer subjects (Rothenberg, 1988b). Control halves of each group were also asked to produce art or literary metaphors in response to side by side slide presentations of each of the individual component images. Results were the statistically significant greater production of both creative literary metaphors by writer groups and creative pastel drawings by artist groups in response to the superimposed images in comparison with responses to the side by side presentations seen by the controls. An example of a test superimposed stimulus image,



Figure 1 The first slide pair, separate (B and C) and superimposed. (A) Photograph of colored slides as projected superimposed onto the viewing screen. Photographs of individual color slides.

consisting of nuns in front of St. Peter's and racing jockeys is shown in [Fig. 1](#). An experiment using shorter stimulus exposure times to facilitate more rapid mental superimposition and manipulation produced similar results. ([Rothenberg and Sobel 1981](#))

Superimposed Experimental Images

With highly talented award winning artists, another experiment was carried out to assess whether the results of the previous experiments could have been due to stimulus presentation effects. Results were that presentation of test superimposed images in controlled comparison with foreground-background (gestalt) displays of the same subject matter yielded significantly higher rated creative products. ([Rothenberg, 1988b](#))

Sep-Con Articulation

The sep-con articulation process consists of conceiving or constructing separation (sep) and connection (con) concomitantly. The term derives from the root meaning of articulation as joining, joint, to join, and the commonly applied phrases, "being articulate" or "an articulate speaker." Speaking smoothly and continuously, the articulate speaker joins words and ideas together and keeps them clearly separate at once. In creative work and activity, the creator uses such concomitant separation and connection, the process of sep-con articulation, in many different dimensions—conceptual, perceptual, affective, and physical. It differs from blending ([Turner, Fauconnier, 1999](#)), fusion, combining, connecting or connectivism alone, in that, with the sep-con articulation process, the creator brings together separate component elements that retain their individual characteristics.

Integration characterizes created works and is a crucial factor in their positive value. The process of sep-con articulation, because of discordance of concomitant separation and connection, leads as with conflicting elements of the janusian and homospatial processes, to dynamic interaction and the emergence of integration. Separate individual elements retaining their identities contribute to the functioning of a large or small whole connected system. This integrated whole has qualities not present in any individual element or factor; it is greater than the sum of its parts.

When creators produce new ideas, procedures, experiments, neologisms, plot themes, artistic or musical patterns, they integrate them into a created result by means of the process of sep-con articulation. Integration, contingent organicity, and usefulness produce the value aspect of creations in all fields, the sciences and arts as well as the products of everyday ingeniousness. Newness or originality alone does not guarantee successful application or appreciation. New elements, forms, or mechanisms must have articulating concomitance with previously existing elements, forms, or mechanisms in order to become creations. New factors must have connections with comparable past ones. Creative new experiments, for example, are always connected to some degree with existing canons of scientific knowledge, creative new post-modern sculptural or painting styles are in some part connected with

realism, op and pop art, action painting and many other previous approaches. Joyce's and Shakespeare's literary creations are connected, both in subject matter and form, with previous works of literature and life events. New factors, therefore, which are clearly distinct and separate are at the same time connected in some measure with the past. Creations are articulating concomitants of new ideas, objects, and structures with aspects, sometimes totalities, of the past.

Sep-Con Articulation in Science

(IntNLS) Physicist Norman Ramsey conceived the "Separated Oscillatory Field Method" which provided critically important high resolution in atomic and molecular spectroscopy for the production of the most precise atomic clocks. He disclosed that he had been working on making a connection between a short and longer magnetic field apparatus and had first conceived that the nature of the field was crucial and *also* that it would have to be uniform. Then, deciding later all at once that the uniformity of the field itself was less important than the separated beginning and ending, he conceived a solution in which the distinctly separated "bits," were concomitantly connected through oscillations. The interactions between the concomitant separations and connections produced mutual modifications and a creative outcome. He said to me, "[the connecting oscillations produce] a short, much stronger field at the beginning and a short, much stronger field at the end, and then the middle part averages out."

(IntNLS) Chemist Jean-Marie Lehn is responsible for the creation of the field of supramolecular chemistry, developments in which have made important contributions to nanotechnology, work with catalysts and catalysis, pharmaceutical therapies, and drug delivery. "Supramolecular chemistry," he said to me, "has to do with the designed manipulation and use of weaker interactions, weaker forces, compared to intramolecular ones, which glue molecules together and allow you to construct large architectures."

He developed supramolecule structures from conceiving concomitant separation and connection: "What one wanted was building a three dimensional negative image in space ... This is a cavity, a 'crypt;' so there are 'cryptands', 'cryptates', and so on The hidden aspect is important because the interactions of the outside species with what is hidden determines both the properties of what is inside ... and also what's outside".

Table 3 denotes the results of the subject Nobel laureate groups' use of sep-con articulation in attaining their creative discoveries as determined through the controlled interview study described earlier.

Sep-Con Articulation in Art, Literature, and Music

In literature, the development of characters results from the process of the author's sep-con articulation of self. Created literary characters are neither simply representations of the writer's personality or life history nor combinations of these factors with those of other persons, real or imaginary. Throughout the course of writing a novel, play, or poem, the author concomitantly connects and separates his own emotions, personality characteristics, and experiences with the fictional characters being created. There is continual interaction of features of the author's self and the developing portrayal.

The sep-con articulation process also operates in the creation of poetic form. (IntPP) James Merrill created a central metaphor, "a mastermind kept track above the mantel" of the poem entitled, "18 West 11th Street" through concomitant separation and connection of words pertaining to his self and the destruction of the eponymic house. It was the street address of a brownstone house in Greenwich Village that Merrill lived in as a child. The house much later was actually accidentally blown up by a revolutionary group called "The Weather Underground" during a project of making bombs in the basement.

The "mastermind" mirror in the poem allows a passing through in imagination of both the poet's childhood images and the world of the Weather Underground. During the process of creation, he wrote more than twenty-five different versions of these lines. Before the final step, he focused on an off-rhymed word-pair, "mental" and "mantel." Then, in the process of sep-con articulation, he conceived the metaphoric word "mastermind" by taking from "mental" the separate idea of "mind" and connecting it concomitantly with the idea of saboteurs or masters from another portion of the poem. He was aware at the same time of separating out the initial consonants and vowels of the word pair "mental" and "mantel" and connecting them into an effective sound similarity: both alliteration (m sound) and assonance (en/an sound). The mastermind metaphor, effective in both structure and meaning, became an aesthetic integration in the poem.

In his diary, in 1892, expressionist artist Edvard Munch described a visual hallucination of a bloody red sky that provided the inspiration of emotionally charged elements that he distinctly integrated by means of the sep-con articulation process (and, in a lesser other way, the superimposition of the homospatial process), into the famous artwork, "The Screech" or "The Scream" (Fig. 2). Over a period of more than a year, he several times progressively connected and separated himself and his hallucination, as represented by a human subject viewing the sky, with nature.

He first did a drawing showing a solitary man leaning far at the back in profile over a bridge and looking spectator-like at the sky and a boat on a small lake, then later he did a painting depicting the leaning still-profiled man located right at the front of the scene. In the next two charcoal drawing versions, he put a round bowler hat on this same spectator man in profile. After that, in an ink sketch much later in that year, he depicted the then bowler-hatted man facing fully forward and matched the rounded shape of the hat with the curved lines of both the sky and the contours of the man's body – a probable result of conceived superimpositions of the homospatial process. In the final version, first done as a lithograph and later as a painting, he developed critical aspects of the image by presenting the man concomitantly separated and connected with the nature scene. The forward-facing man was portrayed

Table 3 SEP-CON articulation process^a

<i>Nobel Laureate</i>	<i>Functional Separate</i>	<i>Functional Separate</i>	<i>Connection</i>	<i>Sep-con Articulation</i>	<i>Discovery</i>
Georges Köhler	Antibody lymphocyte cell	Myeloma cell	Joining	Unitary cell	Monoclonal antibody
Max Delbrück	Physics	Biology	Phage study	Phage genetic replication	Molecular Genetic biology
	Bacterial host	Phage virus	Interaction	Resistant bacterial variant	Genetic replication
	Minimal error	Investigative factor	“Nailing down”	Principle of limited Sloppiness	Phage biology
Salvador Luria	Resistant bacteria	Non-resistant bacteria	Uniform agent	Genetic probability distribution	Lurian Distribution
David Baltimore	Virus RNA	Tumor cell RNA	RNA polymerase	Messenger and genic replication	Reverse transcriptase
David Hubel	Stimulus	Visual cortex cells	Line of orientation	Orientation selectivity	Functional organization of the visual cortex
Werner Arber	Restriction	Modification	Enzyme	Restriction/modification	Hereditary Mutation in bacteria
Allan Cormack	Inside measurements	Outside measurements	Connected Images	Axial Tomograph	CAT Scan
Paul Berg	DNA molecule	Complementary DNA molecule	Sticky end	Connected DNA molecules	Recombinant DNA
Ivar Giaever	Aluminum	Lead	Electron Waves	Tunneling phenomenon and energy gaps	Solid state tunneling
Sheldon Glashow	Fourth quark	Up quark (also leptons)	Eliminating interactions	Charm quark	Electroweak Theory
Jean-Marie Lehn	Inside molecule	Outside molecule	Surrounding cavity	Three dimensional negative Image	Supra-molecular Chemistry
Baruj Benacerraf	Peptide Series	MHC complex	Ir genes	Genetic control	Genetic immunity
Christiane Nüsslein-Volhard	Segment	Even or odd segment	Pairings	Even and odd genetic pairings	Genetic contributions to early embryonic development

^aThe first column contains the name of the Nobel laureate; the second and third columns designate the separated elements or factors; the fourth column specifies the connection and separation factor; the fourth column indicates the creative discovery. (Rothenberg, 2014)



Figure 2 Sep-con, Articulation Edvard Munch, *The Scream* 1893. Oil, pastel and casein on cardboard. Oslo National Gallery, Oslo. Reproduced with permission.

with no hat but with an oval screaming mouth. Both the red sky and man's body contained differently oriented ovoid types of curves. Mouth, sky, and body all were in this way separated and connected concomitantly. He thereby produced a universal pictorial metaphor, a metaphor verbally described as "the scream of nature," that provides much of the integrated aesthetic power of this painting.

The process of sep-con articulation operates throughout musical creation. Just as the articulate and creative speaker brings phrases and ideas together smoothly and in continuous flow while concomitantly separating these phrases and ideas clearly, created music brings rhythms, themes, instrumental effects, and other sonorities together smoothly while constantly separating these elements. It produces the organic integration of music. Classical composer Paul Hindemith, using the analogy of seeing a heavy flash of lightning in the night, described the musical operation of the homospatial and sep-con articulation processes both together as follows:

"Within a second's time we see a broad landscape, not only in its general outlines but with every detail We feel that not even the smallest leaf of grass escapes our attention. We examine a view, immensely comprehensive and at the same time immensely detailed Compositions must be conceived the same way. If we cannot in the flash of a single moment, see a composition in its absolute [connected-A.R. added.] entirety, with every pertinent detail in its proper place, we are not genuine creators.

Phases of Janusian, Homospatial and Sep-Con Articulation Processes

All three processes function in creation individually as well as in conjunction with each other. There are four phases in the creative process that occur over extended periods of time or are else condensed into a very short span such as sometimes occurs with sudden breakthroughs and insights. Ordinarily, the creative thinker uses the janusian process earlier than both homospatial and sep-con articulation processes. All three begin with an overarching first phase consisting of the deliberate motivation to create; nothing new and valuable is created without the intention to do so. Both the intentional goal and the area chosen for creation always have emotional (including aesthetic) importance for creators themselves. Combined emotional and ideational motivation provides the drive to conceive the inconceivable and use other daring and unusual cognitive modes in the next phases.

In the second phase for each of the three processes there is a deviation from the customary. The creator using the janusian process focuses increasingly on seemingly unreconcilable poles of opposition or antithesis. Scientific creators, highly knowledgeable about their fields, at this time begin to break away from widely, even strongly, held precepts of approach and content. In art, literature, and

music, knowledgeable creators' choices of particular opposing elements of form or content in their works differ in some fashion from those of previous writers, artists, or composers. This is the beginning of a departure from the known and accepted that ultimately produces newness in the created product. Creators' gradual and continuing development of specific thematic poles and aspects serves to separate and isolate critical factors in the area of investigation, technology, or aesthetic production.

In both the homospatial and sep-con articulation processes, in the second phase, creative thinkers choose entities that, while they differ both singly or in multiples from the usual, have functional or structural similarities with each other. For the visual artist it may be repetitions, juxtapositions, contraries, or oppositions in shape and color, for the writer (especially the poet) and musician it may be sound, communal and physical relationships, and for the scientist it is functional, conceptual, or physical relationships within the problem being worked on.

In the third phase of the janusian process, creative thinkers conceive multiple opposites or antitheses as operating simultaneously. It is here that ideas constructed sometimes seem surprising to the creators themselves. At first unthinkable, even disjunctive, are postulates that antithetical factors co-exist or operate together, or that something that has existed or was known previously continues to operate together with its diametric opposite. Also, one pole or portion of an opposite or set of opposites may up to then have been in conscious focus while others have been dimly held at the periphery. Conscious positing of the simultaneous validity of these opposites may become a sudden and enthralling experience, producing a sense that is sometimes described as "something coming out of the blue" or projectile. With respect to newness, the simultaneity of opposition is a phenomenon experienced as being out of time. As it is out of time, or out of temporal succession, it is discontinuous with previous factors and therefore distinctly new.

Distinct cognitive abilities and proclivities are involved in the janusian process and emotional underpinnings interlock with these. When emotional involvement involves meaningful conflict, it especially jibes with the cognitive tendency in the janusian process to focus on opposites and antitheses and bring these together simultaneously. The simultaneous opposition and antithesis with its retained conflict among composing elements is isomorphic with emotional conflicts, both open and hidden, for all types of creators.

In the third phase of the homospatial and sep-con articulation processes, creators bring together the collected functionally or structurally similar elements. With the homospatial process, they are superimposed or interposed in the same mental space; with the sep-con articulation process they continue to be separate identities while they are connected. Creators bring together these entities because they conceive that they ought to be together. The conception deviates from previously known composite structures in a manner similar to the types of deviation of the janusian process. There are several reasons for conscious deviation, many of which are emotionally driven and may be unique to the particular thinker.

In the fourth phase, both the homospatial and sep-con articulation processes lead individually to partial or complete integrations. Also, they operate together with the janusian process, modifying it and integrating the simultaneous opposites into the full dimensions of the artwork, theory or discovery. Stepwise logical and synthesizing mental processes operate in this phase as well. Not to be minimized in any way, specific skills are critically important, such as, in science, high intellect and intelligence, observational and deductive capacities, and knowledgeable attention to canons of empirical validation. In art, music, and literature, high level skills with language, sound and pictorial relationships are necessary to produce the fully developed aesthetic product. Other specific skills are distinctly necessary for creativity in various other fields.

Aspects of both janusian and homospatial processes have features in common with sep-con articulation. Opposites and antitheses in the janusian process are both separated and connected when simultaneously posited. In the homospatial process, discrete separate entities become connected within the same space. Sep-con articulation is used conjunctively throughout all phases of the creative process, interacting and interlocking with the various phases of both janusian and homospatial operations. Creators use it independently primarily in the fourth phase construction of the completed work. Overall, the sep-con articulation process has a biphasic configuration. In the early aspect, the person who is motivated or "inspired" to create takes in emotionally laden stimuli, experiences, and concepts. Analogous with the literal meaning of the term inspiration in breathing or respiration, the taken-in contents are, like elements in inspired air, modified. Mentally, these modified contents interact both consciously and unconsciously. Not simply expelled or expired, through such postulated mechanisms as unconscious breakthrough or as catharsis, however, the contents are consciously sep-con articulated. Similar to the everyday creation of human utterance in which inspired air is articulated by the voice apparatus and the brain to construct words and language, the sep-con articulation process modifies initially taken-in inspirations in an extended final phase.

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Jungian Theory[☆]

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Glossary

Analytical psychology A psychological science, developed by Carl Gustav Jung, that grew out of psychoanalysis and includes theory, research, and practice.

Archetypal image A representation, or motif, of an archetype that has infinite manifestations. The produced archetypal image gives a voice to the archetype itself and is commonly found in fairy tales, legends, religion, mythology, dreams, and art. Also referred to as a primordial image.

Archetypes Limitless instinctual forms, not yet ideas or representations, within the collective unconscious thought to be passed down through the ages and found in all cultures. Archetypes are not visible until an image is created.

Autonomous complex An emotionally charged part of the psyche that usually includes material from consciousness as well as the unconscious. Forms the connection between the personal and archetypal parts of a person. Autonomous complexes, which are many, include the creative complex.

Collective unconscious The second layer of the unconscious, preceding the personal unconscious, which houses the archetypes (often used interchangeably with the concept of archetypes, defined above). Considered the reservoir of great art.

Individuation The cornerstone of Jung's theory of personality development. The process is lifelong and the goal, which is attainable only in stages and not in total, is to become whole, complete, and truly individual. Making great art is linked to this process.

Personal unconscious The first layer of the unconscious that stores traumatic memories, experiences, and ideas that are unique to the individual's past. This layer of the unconscious precedes the collective unconscious.

Symbol The greatest conceivable expression for an idea; the idea cannot be produced in a better way. Symbols can be recognizable connections to archetypes, but their actual meaning is unknown. Great art is truly symbolic.

Wholeness The ultimate form of expression of all parts of the personality to one's self, others, and nature. Being psychologically whole equates with health, and health equals creativity—the goal of individuation.

Carl Gustav Jung—The Man

Carl Gustav Jung was born on July 26, 1875, in Kesswil, Thurgovie, Switzerland (also spelled as Kesswil, Thurgau, in other biographies). His family was economically poor. Jung's father, a Doctor of Philosophy, worked as a pastor in the Swiss Reform Church and was also an Oriental and classical scholar. His father was described as quite conventional in his religious beliefs, from which Jung later strayed. By some accounts, Jung believed his father was weak. Jung's mother was thought to be inconsistent and divided in

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her thoughts. She often contradicted herself. He seemed to identify with her in many ways, especially regarding his intensely complex inner world and the two strong parts of her personality that opposed one another.

This opposition was part of Jung's experience of himself (and later a central part of his theory of personality). When Jung was 3 years old, his mother was hospitalized for several months, probably due to problems in her marriage that continued throughout his youth. Over time, Jung developed mixed feelings for his mother. Jung was a highly sensitive, curious, and bright child who had several bouts of physical illness. He was acutely aware of his thoughts, feelings, and surroundings. Growing up in the country afforded him a great deal of pleasure and a place for exploration. He enjoyed the beauty of his homeland and was in a frequent state of discovery about the world around him.

The beauty and brightness he experienced was contrasted by several dark experiences that followed him for much of his life. The dark experiences included themes of death, religious activity, dreams, and fears. This duality serves as the cornerstone for much of his theoretical frame. Jung took playing quite seriously, and playing alone became a constant for Jung as he was an only child until the birth of his sister when Jung was 9 years old (he had a brother who died 2 days after his birth, 2 years preceding the birth of Jung).

He was quite interested in Eastern religion, mythology, and nature as a young boy. Being alone allowed him the space to ponder the many questions he had about life, especially religion. Some believe that the materialization of analytical psychology was his way of finding a replacement for religion. He did not have any companions that he trusted enough to share his meaningful ideas or questions, and thus he felt even further isolated.

School for Jung was wrought with ups and downs. At times he was strongly engaged and at other times he was disengaged. His interest varied depending on experiences he had with other students and his teachers, as well as their perception of him.

After much deliberation, Jung decided to attend medical school. He struggled with this decision because he originally wanted to study natural science or the humanities. Psychiatry, which became known to him late in his academic career, was his final choice as a specialization. He found his university experience exciting and challenging. In addition to medicine he was able to continue his study and exploration of theology, philosophy, and Eastern theories.

After finishing school in 1900, Jung moved to Zurich, Switzerland, where he lived for the rest of his life. He began training at a psychiatric hospital in the city. For the first 6 months he lived in the hospital, immersing himself with psychiatric literature and learning firsthand what the experience was like.

Here he became fascinated with the minds of patients with many disorders, including schizophrenia. Many of his theories originated from his work in the hospital. He became rather disillusioned by the way patients were treated and began to experiment with alternative therapies. This disillusionment led him to the work of Sigmund Freud.

Jung published his first paper in 1902 and began lecturing at the university in 1905, meanwhile building a private practice in Zurich. In 1907 he met Freud. From the beginning, Jung was reluctant to embrace many of Freud's theories, yet conversely he was intrigued with Freud and his work. At times Freud and Jung worked closely. Jung was beginning to formulate more of his own theories and had trouble accepting key ideas in Freud's theories. Yet he found himself unable to disagree overtly with Freud as Freud saw him as a loyal protégé. The final break between the two men occurred with the publication of Jung's book on libido (psychic energy) in 1913.

Jung's work was rejected by many of his friends and colleagues leaving him isolated once again. The next 4 years were wrought with a great deal of distress, mystery, and growth. Some reports indicate that Jung had a psychotic break primarily because he was experiencing visions and emotional turmoil. Through these experiences he began to further understand the workings of his unconscious, which led him further along the path to the idea of the collective unconscious.

He studied his dreams and fantasies, drew pictures of his visions, and began to create mandalas (circular drawings that become central to his theory of individuation). This creative and very dark period gave him material to sort through and define for the rest of his life. He did not understand all that was occurring; only that it was significant, and later the meaning would be revealed.

From 1918 to 1919 Jung came out of his so-called darkness. He attributed the change to ending a relationship with a woman who continued to believe his fantasies were inspired by his art. He adamantly opposed this assertion. Some writers point to the curious nature of his insistence on this matter. For when he was a young boy he derived great pleasure, and felt successful, making art. The second factor that released him from his darkness was his understanding of the mandalas he created. Jung found them to be a way of journaling his internal growth.

Jung continued on this journey of understanding the psyche, especially that of the collective unconscious. He traveled throughout the world, which gave him greater evidence for his belief in the collective unconscious and the role of archetypes. Everywhere he visited he was able to see connections to the archetypal and mythical world. The common images existed despite cultural, language, or age barriers.

Jung spent the majority of his life writing about these experiences as well as maintaining an esteemed clinical practice. Jung married in 1903 and had five children. Jung's wife, Emma, also an analyst, contributed to the work of analytic psychology and wrote several works. At the time of his death in 1961 he had 19 grandchildren.

Most of his life Jung was frequently sought after by students and deeply respected. He received many awards throughout the world. He contributed enormously to the field of psychology and continues to have a great number of followers with Jungian analytic institutes worldwide.

Model of the Mind

Jung's theory of the mind rests on the concept of opposites and opposite forces, which is important to be mindful of as his theory unfolds. This section provides an overview of several key concepts of Jungian psychology, including the ego, consciousness, personal unconscious, collective unconscious, individuation, and wholeness. Whenever possible, the implication to the creative process associated with the corresponding structure of the psyche will be made. Psyche, or psychic material, refers to the entirety of both conscious and unconscious psychological processes. The psyche is very complex and works to keep itself in balance.

The Conscious Mind

The conscious part of the mind has the primary job of sustaining the relationship with the ego. The ego is a complex (see autonomous complex in glossary) that contains a great deal of continuity and identity. For psychic material to be conscious, the ego must be aware of the material. Conversely, when psychic material is unknown to the ego, it remains unconscious. Awareness in this case is not merely intellectual but rather intuitive, emotional, and with meaning. Further, consciousness is thought of as the opposite of the unconscious.

The Unconscious Mind

The unconscious is the second psychic structure to which Jung referred. Consciousness is the unconscious' opposite and houses information that is not accessible to the ego but may later be accessible. The unconscious is vast in size and fluid in movement. The relationship, or link, between consciousness and the unconscious is referred to as compensation. Compensation means balancing or adjusting. In this case, compensation comes into play when consciousness is too one-sided, leading the unconscious to try and reach a balance. The personal and the collective are the two substructures of the unconscious. Both substructures serve as a source of art, although in very different ways (which will soon be illustrated).

Personal Unconscious

The personal unconscious, the first layer, is that part of the unconscious specific to the individual. Included in the personal unconscious are repressed memories (memories that have been pushed down into the unconscious without one's control), ideas that are painful, and information without the strength, or the timing, to reach consciousness. Material in the personal unconscious was once conscious and may later be conscious again.

Collective Unconscious

The collective unconscious, the second and deeper layer, is that part of the psyche that is shared by all people, in all cultures, throughout the ages. Jung believed that the collective unconscious is much more important than the personal unconscious because it is the seat of power, wholeness, and internal transformation. The collective unconscious holds dreams, visions, religious experiences, and myths.

He arrived at the idea of the collective unconscious through his knowledge of mythology, anthropology, religion, and art. The collective unconscious concept was further materialized from Jung's work with patients who were diagnosed with schizophrenia (importantly, the collective unconscious is found in everyone, not just in psychotic patients). Furthermore, in his work he realized that images in people's dreams were not from their own personal experience, or life, but rather reminiscent of archaic symbols and images. He began to recognize these images in ancient works and religions that were not in the awareness of the patients who told him their dreams.

In many of Jung's original writings he unknowingly referred to the collective unconscious and the archetypes interchangeably. This confusion has led subsequent authors to speak of the collective unconscious and the archetypes together, not as separate structures. Archetypes are universal structures in the collective unconscious that allow for the potentiality of ideas, but they are not ideas themselves. This point is often a source of confusion and the distinction is important to understand.

Archetypes are revealed by the archetypal image they represent in consciousness. The image is what gives proof of the existence of the archetype. You cannot see an archetype; you can see an archetypal image. Archetypes, and archetypal images, have a strong creative force along with many other qualities. Among the qualities present are favorability, emotion, number, intensity, and type. Archetypes are neither all bad nor all good. Rather, they simply exist, and understanding the importance of the structure is what is key. Intense emotion exudes from archetypal images. Experiences may be within the likeness of all human behavior, but the experiences that manifest within the archetypal category are extraordinarily human; emotional response to an archetypal imagery is enthralling, bigger than life.

Because of the emotional magnitude of the archetypal image it acts as a communication device from the unconscious mind of the individual who produced the work, to the unconscious mind of the individual seeing or reading the work, through the symbolism inherent in the image. The communication is further enhanced by the image relating to mythological figures, or motifs, from ancestry. The manifestations of archetypal images change based on the current culture but are always linked to the past. When an archetypal image is seen or heard or read it evokes a great deal of emotion, power, and release. It is as though the experience is connected to the individual's past and the past of all mankind.

Examples of Archetypes

There are infinite numbers of archetypes and archetypal images. Some of the key archetypes that will be discussed are the anima and the animus, the shadow, the persona, and the self. Other archetypes are the mother, father, warrior, and wise old man, to name a few.

Unconscious archetypes of the opposite sex are referred to as the anima and animus, in Latin these words mean “the soul.” The anima refers to a man’s image of a woman, and animus refers to a woman’s image of a man (which Jung viewed in traditional roles of the 19th century). The anima and animus are thought of as guides, primarily throughout the terrain of the unconscious creating a richer level of understanding of one’s internal world. Another way of thinking about the anima and the animus is in their role of moderating between the conscious ego and the unconscious mind.

The anima was intensely studied by Jung as well as his followers. Less was written by Jung, and his followers, on the concept of the animus. The anima and animus are important for many reasons, especially in relation to the creative process. They are both portrayed continuously in fairy tales, myths, literature, film, and other art forms.

The shadow is another archetypal figure or image. The essence of the shadow is that part of everyone’s personality that is disliked and incongruent with how one would like to be perceived—the part that harbors unacceptable feelings, thoughts, or wishes; distasteful impulses; and negative assessments of oneself. The shadow is actually the part of oneself that an individual can only see sometimes and in varying degrees. Just as the sun creates shadows on all that catches its light, the shadow can be further thought of as the darker, uglier, and evil side of life (e.g., violence, wars, and tragedy, as well as that part of the person who commits such crimes). Further, the shadow is the side of the personality that most people would wish to disown or pretend did not exist. The opposite, or counterpart, to the shadow is the ego. The shadow is often portrayed in movies, books, and art of all kinds.

Persona is the archetype Jung referred to as the mask that everyone wears at times. The persona is thought of as the mediator between the ego and the outside world. The concept of the mask suggests that people respond to the expectations of society by presenting themselves in a certain light, even though the persona is not the true or complete self. In extreme instances, the mask, or persona, is represented in the person who cannot leave his or her professional identity aside. For example, the lawyer is always arguing a point; the preacher is always wearing his or her religious garb and reading from the Bible.

The self archetype is that of wholeness and completion. The self further refers to the ability of the conscious and unconscious to work together in order for an individual to be free to be her or his true self. The integration of all parts of the psyche allows the individual to live in a creative and symbolic fashion—to be truly an individual. The self archetype is the representation of individuation, which will soon be discussed.

Another concept often compared and contrasted to archetypes is the complexes (referred to in the section on consciousness). Jung suggested that there are many complexes in the psyche; unlike the archetypes that number is finite. However, like the archetypes they are neither all bad nor all good; rather they are a part of the psyche to be understood. The autonomy of the complex is possible because the conscious mind does not regulate or control the information. The autonomous complex operates when there is enough energy to move information from the unconscious to consciousness. Even though the information is conscious it is only perceived, not known. The creative complex is one of the autonomous complexes. The autonomous complex is the living part of the creative process, the part that takes on a life of its own (which will be discussed in detail).

Dreams

Jung’s approach to art was similar to his approach to dreams. Jung was inspired by the element of surprise when one awakes, with an uncensored dream. Just as dreams can be puzzling, often the same can be said of art. Dreams can incite further personal inquiry as can some art. The viewer or reader questions art and allows the wondering to pull up unconscious material, just as a dream might.

Individuation

This section provides an overview of the concept of individuation including the concept of wholeness, the integration of mandalas, and the production of active imagination. The process of individuation is key to understanding Jung’s theory of creativity. Individuation further includes the integration of the conscious mind, the personal unconscious, and the collective unconscious.

The cornerstone of Jungian, or analytic, psychology is individuation. The process of individuation, likened to his description of the creative process, is the road of integration between parts of the self that are conflicted. The concept is that opposing parts of the psyche, both conscious and unconscious, are brought into harmony. In addition to the internal work required for individuation is the external work of increasing one’s individuality. Thus, individuation includes both internal and external movement. Full individuation can never be reached; instead Jung believed that it was best to approach it as a lifelong process. Importantly, not everyone chooses or is able to travel down the road of individuation.

The purpose of individuation is to bring about wholeness in the individual. Wholeness suggests that one is able to fulfill one’s destiny and vocation. Wholeness allows the individual to be authentic in the world, thereby avoiding using only the persona, or the mask. Being aware of one’s own internal reality is at issue, not getting rid of a part of the self that is disliked. Coming to terms with the darkness and the painful images in the unconscious is a necessary part of individuation. Also included in the process is greater awareness of the collective unconscious and the collective world around each individual, thus avoiding isolation. A sense of wholeness further encompasses the spiritual aspect of life.

Through the process of individuation, with the hope of reaching wholeness, is the production of archetypal images. These images allow psychic material from the unconscious to become conscious, in varying degrees, thereby freeing difficult material in the collective unconscious. In the case of the artist, moving further along the path of individuation with the production of art subsequently provides the viewer or reader of the art with a similar experience—that of individuation.

One form in which individuation may be expressed is through the making of mandalas, which are a symbol of the psyche's center, or the self. The self, an archetype, is reflective of both conscious and unconscious parts of the psyche. The creation of mandalas was for Jung a tremendous experience of integration within himself, of unconscious and conscious experience. The mandala is a circular drawing usually divided into fourths, or derivations of four or eight. Mandalas are actually used in the East as a form of meditation, although at the time Jung began making them he was not aware of this historical element. He considered this work to be in the realm of religion as opposed to art.

Others have considered the mandala to reside equally within the realm of art. The argument is that a work of art is also an integration of the inner world of the artist and the external world in which the artist lives—again, a representation of the unconscious and the conscious parts of a person.

Another route to individuation is through active imagination, a fantasy activity primarily used by Jung with his patients and with himself. Introspection or meditation is at the center of the activity. Active imagination allows the individual to have a dialogue between consciousness and unconscious. Jung was not certain if the unconscious rules over consciousness or if consciousness rules over the unconscious during active imagination. The key point is the interaction between the two structures of the psyche, the conscious and unconscious, leads to a greater sense of wholeness and individuation.

The form of active imagination can take various shapes such as painting, drawing, writing, and so on. The end result is not what is of primary importance but rather the interplay in the psyche of the creator and the creative process. Jung found that during active imagination, people were able to tap into their unique creative potential. He did not regard this act as making art per se, but rather engaging in their own process of creation.

Artistic Creation

This section provides an overview of Jung's conceptualization of the source and process of creativity, as well as his perception of the artist who creates. Jung was very cautious in his understanding and interpretation of artistic creativity, and he was primarily interested in literature, although he made references to all of the arts. He did not offer a complete theory of art primarily because he wrote on so many other topics, and because of his desire to resist overanalyzing art. As such, he was careful to identify the limits of his psychological study of art activity. In fact, he probably would not have touched the topic if he did not consider making art to be in the realm of psychology.

In general, Jung believed that the process of creation has a feminine quality and the creative work is that of the "mothers," an archetype, within the collective unconscious. As previously stated, much of Jung's theory emphasizes the role of obtaining balance regarding the opposite poles within the individual. The making of art follows through with this idea. When the artist is out of balance psychically, the archetypal image rises to the surface to restore harmony in the individual and, in turn, society, thus aligning with the concept of individuation.

Jung made a distinction between the artist and the actual work of art. Artwork may provide inklings to the artist's life but not reveal the unique qualities of the person who created it. Just as the artist's life may provide clues to understanding the work but not shed light on the meaning entirely, Jung felt strongly that psychology can never fully understand the causality of any work of art largely because the creative urge originates in the unconscious. A reductionist approach to understanding art was contrary to Jung's position. (A reductionist approach to art is attempting to trace all the elements of a work of art to the artist's past.) He was in favor of experiencing a work of art (poetry, paintings, literature, etc.) on its own terms instead of looking for the psychological reasons, or causes, of art. Even though the material of the work can be linked, or traced, to the artist's past, this does not allow others to then understand the actual meaning of the work. In this way, Jung saw the artist as quite separate from her or his creative work. In other words, a work of art in some cases transcends the person and is thus a separate entity. Jung was primarily interested in this type of work, later referred to as type two, or visionary, work.

Types of Artwork

Work that transcends the artist and work that does not was further described by Jung in the following typology. He identified two types of art: one derived from the conscious mind and the second from the unconscious mind. The first type of art is controlled, conscious, and made with a specific intention. Jung later referred to this type of literature as psychological in nature. Psychological, in this case, refers to work that is derived from consciousness such as stories of love, family, crime, and society. These works are easily understood. Artwork of this type, whether literature or painting, is deliberate in that the artist knows exactly what he or she is intending to create. The artist and the creation are one; there are no surprises.

In contrast, the second type of art is unconscious, is uncontrolled, and amazes the artist. The work produced takes on its own form and structure. This type was described as Visionary which does not exclude the psychological quality; rather it goes beyond the personal psychology into the suprapersonal realm. Visionary works are unfamiliar, strange, gigantic, and superhuman.

These works speak to the depths of the human psyche and the beginnings of human existence, holding ideas that transcend the words or images set forth. They are symbols of something unknown. Darkness surrounds them. Visionary works are primordial, or archetypal, experiences rather than personal experiences. The origins of the creative process are the primordial experiences, but the mythological figures give the work conformation. The primordial images, or archetypal images, are dark (e.g., demons and spirits). The mythical figures bring lightness to the dark by appearing less frightful or intense thus bringing harmony to the imagery in a way that is digestible for the current times.

These works are extremely important because they originate in the collective unconscious and bring a message for future generations. Positive or negative, the message is ultimately of value. The artist who produces the second type of work is astonished almost to the point of disbelief. In this experience the artist feels as if someone else has created the work. He or she must allow the process to occur, but not in his or her control. The artist is the vehicle in which the creative process transcends. The artist and the creative process are separate; there are always surprises.

A further distinction is made between the first and second type of artist. The distinction rests on the type of activity set forth by the artist. The first type of creative activity is thought to be introverted and sentimental. Here, Jung borrowed from the work of Johann Schiller in his conceptualization of sentimental and naive. Introverted refers to Jung's idea that the artist consciously shapes and controls the artwork. On the other hand, the second type of creative activity is extraverted and naive. Extraverted refers to the idea that the artist allows the work to control him or her. In other words, the artist's unconscious takes over.

The action of the unconscious is thought to be the creative urge or impulse that may, in a sense, take over the person. The creative urge arises out of the psyche and is extremely powerful. At times, the urge is so strong that everyday life goes by the wayside in order to create. The creative urge is different for all people and varies depending on the type of work produced. The ability to understand both types of work is also different. The first type of work is intentional and comprehensible. The second type of work goes beyond understanding to the same degree that occurred while the artist was in the process of creating it. The image, the poem, or the story can only be understood through intuition and always provides multiple meanings. However, within one piece of work there can be both types of expression.

Further, the second type of art produces a symbol or symbols. A symbol is an expression of an idea that cannot yet be discussed or stated in another, clearer way.

Works that are symbolic are challenging and stimulate the viewer or reader's thoughts and feelings. In contrast, the first type of creative work tends to be more appealing because it is complete, compared to the second type of work.

Symbols are produced for the culture and the spirit, according to Jung. They are a product of the collective unconscious. They are based on intuition and are never planned. Symbols allow society and the individual to move energy from the psyche into valuable accomplishments found in art and science, among other disciplines. Examples of symbolic, or visionary, art are found in the work of Paul Klee, Wassily Kandinsky, Carlo Carra, and Piet Mondrian. These artists were led by visionary images of their inner world that were indescribable.

The inner world is secretive, even to the artists themselves. These artists brought art making to a new level, that of the mystical and the spiritual, though not of a religious order. The manifestation of the spiritual and mystical visions was found in paintings, collages, and unusual figures made from stone, wood, metal, and glass. The tracing of these prominent artists reaches to the time of pagan religions. A very dark nature permeated and was pushed into the unconscious psyche of humankind. Pushing away the darkness created more ugliness and evilness manifested in the form of obsessions, addictions, and so on. Artwork of the beginning of the 20th century (e.g., Kandinsky, Klee, Carra, and Mondrian) brought about a positive resurgence of the primordial spirit in the form of archetypal images.

The part of the unconscious where art originates was important to Jung. He believed that art derived from one's personal unconscious was more a symptom of a problem or situation rather than a symbol manifested from one's collective unconscious. Conversely, art—great art—that is produced from the collective unconscious, or with archetypal images, has a tremendous effect on the viewer. The viewer or reader's collective unconscious is stirred up through the form and shape of the artist's work. In this way, art continues to revitalize connections to the past in a way that is understood by today's culture. Jung believed that this effect revealed the social significance of art and held the artist in high regard. Thus, the creative process is the artists' abilities to manifest archetypal images from the depths of their collective unconscious which is essential for the process of individuation to take place.

In this way the creation of art is what Jung referred to as participation mystique, which is the mystique, or veil, of great art. This movement is in the realm of the collective unconscious. Asking an artist to explain his or her work is unnecessary (largely because great art is beyond explanation), and learning of her or his life is inconsequential and nonexplanatory to the creation. However, he did write the following brief summary about attributes of the artist.

The Artist

Jung saw the artist as an extraordinary human being who is granted the benefit and the tragedy of creative vision. Those who create only, or primarily, from their personal experiences are not in this category. They are expressing a symptom of their experience, as referred to earlier. In contrast, artists who are producing great art must transcend the personal and move into the realm of the collective unconscious, thereby speaking to the mind and heart of humankind. Jung saw the artist as a medium for producing work that speaks for all. He or she does not have conscious control to create or not create but rather is propelled by the collective force to create. The artist does not have a choice.

Not only is the artist a creator but also a human being with wants and desires for everyday happiness and experiences. Jung saw the artist as wrought with conflict because these opposing forces—existence as a human being and as an artist—are not reconciled. Primarily the creator who does not acquiesce to the divine power of creativity that has been granted to him or her will be quite conflicted. The creative force is so strong that there is little energy to do much more in life, namely, the simple pleasures of the average person. The artist is laced with a burdensome existence, often resulting in a selfish, helpless, infantile, and egotistical way of being in the world.

The following analysis of Picasso serves as one, if not the only, analysis of visual art written by Jung.

Picasso

Jung reluctantly and briefly approached the subject of Picasso's artwork, and stayed close to the psychology of his art rather than critiquing his art from an aesthetic point of view. At first he comments on the unfairness of Picasso's work on the viewer, at first viewing these paintings negatively. But eventually the viewer comes to a realization about the world in which these paintings live, an other world. He began to conceptualize this as an entree into the unconscious, which he considered to be dark. He views the images as violent or frightening for some—the opposite of beauty.

Jung's approach followed a chronological history of Picasso's work. Overall, Jung described Picasso's work as nonobjective art, originating from inside, or from his unconscious (earlier referred to as type two artwork). There were a few exceptions, as will be illustrated. Again, work from consciousness, or outer experiences, produces images that are recognizable. The objects may be distorted but not to the degree that they are incomprehensible. Artwork created from the inside takes on a symbolic form, often producing works that are strange, unusual, and not understandable.

Jung viewed four periods of Picasso's work from the blue period to the post-Harlequin period. Picasso's blue period was described as objective, from consciousness. Jung was reportedly concerned with this blue period given the darkness of the midnight blue period which reflected a turn to night. He interpreted the figures in this work as resembling those in the Egyptian underworld. He then moved into a different period, which Jung described as moving into the unconscious, the inside. This period is very dark, characterizing the ugliness and evilness of life. Picasso's work then changed into another form and shape that of the Harlequin, a tragic and ancient god—a very primitive image. The Harlequin image was disturbing to Jung. The period that followed was Picasso's unconscious attempt at conquering his internal conflict—that of opposing forces. The use of piercing, relentless color reflects the strength of the unconscious to handle conflicts of violence.

Summary

Carl Gustav Jung provided a wealth of information to the field of psychology and the process of creativity. From his early days he was ever present to the subtle nuances of the world in which he lived. He was keenly able to integrate his own experiences with those of people around him, from his biological family, to his clients, to his created family. From the beginning he was astonished, amazed, and excited by the duality of life—the secrets of a world of opposites.

This dualism continued to plague and interest him for the duration of his life, and through his own experiences, both internal and external, he developed a complex theory of the human mind. Certainly his theory of the unconscious, with the division of the personal and the collective, was one of his greatest achievements. He has provided a legacy of imaginative, challenging, and intriguing ways of looking at oneself, especially in the creative process.

In his work, Jung provided a theoretical structure of two types of art. The first type is conscious, controlled, and within the realm of the personal. The second type is without limits and truly the work of the collective unconscious, or the archetypes. The second type of art was the focus of Jung's interest because it is the work of the primordial. The images that arise from the collective unconscious are symbolic. Symbolic images are the magical images that the viewer relates to with great emotion although not really understanding why. It is through this process that Jung's theory of individuation comes into play, both for the artist and for the viewer or reader. Again, bringing into play archetypes in the collective unconscious, giving them a voice, and allowing others to experience the transcendence into their own collective unconscious are the stuff of great art.

Jung held great regard for the artist. He believed that the artist was chosen, that the artist did not choose to become a creative agent. The artist's life was wrought with conflict over the unbearable creative urge, on the one hand, and the desire to live an everyday life, on the other hand. Jung believed the artist was a true visionary.

In closing, Jung believed that the creative process was central to having a sense of wholeness within oneself. The sense of wholeness provides the individual with an ability to be a true individual. The process of individuation is achieved through a number of different means with the end result, which is never wholly attainable, being that of an increased sense of self.

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Knowledge

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Introduction

The role of knowledge in creative thought has been examined extensively in the study of creativity. Although intuitively it may seem that greater knowledge would lead to higher quality ideas, the unique demands that creativity poses make the relationship between knowledge and creativity less straightforward. While knowledge contributes ideas and information relevant to solving ill-defined problems, creativity further requires a restructuring of this information and the integration of new concepts to generate novel and elegant solutions. An overreliance on knowledge in one domain may impede the deviation from previous ideas, constraining focus on what is known rather than what new information could be utilized to develop novel pathways to solving complex problems.

Accordingly, this entry will discuss the role of knowledge in creative thought and discuss recent research streams that shed light on the complex relationship between knowledge and creativity. After first defining knowledge, the available evidence from the literature as it relates to the interplay of knowledge and creativity will be discussed. Finally, considerations for knowledge management will be reviewed.

Knowledge

Knowledge, broadly, is a set of mental structures that are used to both organize and store learned information. Different types of knowledge are organized into different domains, which then are organized into schemas. Schemas are conceptualized as cognitive

structures that consist of linkages among concepts within a domain. Ideally for creativity, domains would be both 1) highly complex with multiple schemas and multiple attributes with many linkages across concepts, and 2) highly flexible, meaning that new schemas and linkages can be created to create novel and unique ways to combine concepts.

The structuring and organization of knowledge is a key component when understanding the link between creativity and knowledge because they provide a framework for how concepts may relate or may be able to be combined to form original and high-quality ideas. Discussion about knowledge and its relation to creativity pertains to whether and how experts, people with high levels of domain-specific knowledge, differ in their creative performance with novices, those who have lower levels of expertise or knowledge in a given domain. Answers to such questions reveal that the benefit of knowledge for creativity is contingent upon the types of knowledge involved and how they are used. To understand how and when knowledge can hinder or benefit creativity, it is first important to the types of knowledge that contribute to creativity.

Types of Knowledge

There are a number of taxonomies representing the different types of knowledge, differentiated by their basic units, organizing principles, and use. The role of knowledge more broadly across creativity research will be discussed in terms of its competing counterparts: depth and breadth of knowledge as well as content and operations.

Depth Versus Breadth

A key feature of knowledge is its domain specificity; knowledge or expertise learned in one content domain is not easily transferrable to other domains. Consider the differences in content across languages. The knowledge that one has regarding vocabulary and the rules of grammar and sentence structure in one language, such as Italian, does not transfer to knowledge of a different language, such as Mandarin. This also applies to knowledge of the sciences or broader industry knowledge.

Studies of the relationship between depth and breadth of knowledge to creativity resulted in mixed findings. Knowledge depth can be conceptualized as extant knowledge in one domain, consisting of more concepts and complex linkages within and across schemas (Mannucci and Yong, 2018). In contrast, breadth refers to knowledge in multiple domains. Scholars have set out to investigate whether depth or breadth of knowledge is more beneficial to creativity. A depth of knowledge could contribute a greater complexity of schemas within a domain with many linkages across concepts. However, knowledge across domains could provide mental linkages across concepts from different domains rather than constraining cognition to linkages across concepts within a domain.

In some studies, evidence was found that individuals with a depth of knowledge generated more novel ideas through the utilization of their complex schemas within a domain. In other studies, individuals with a depth of knowledge became cognitively entrenched so that individuals were unable to deviate from current linkages between concepts. Here, knowledge constrained individuals from being able to form new and original linkages and this hindered their ability to be creative. However, large amounts of knowledge across domains can also lead to information overload, which impairs an individual's ability to sift through these different domains of knowledge and pull only relevant and useful information.

In a study of core crew members who worked in the Hollywood animation industry, scholars attempting to address the question of whether depth or breadth is more beneficial for creativity tested the idea of career age playing an important role (Mannucci and Yong, 2018). The researchers found that the rigidity of knowledge structures was positively related to career age. They also found that the knowledge depth and knowledge breadth are more favorable at different stages across the age of a career. Knowledge depth was found to be more beneficial at early career stages of a career with knowledge breadth found to be more beneficial in later career stages. Overall, this study showed the importance of knowledge complexity, as well as the pitfalls of rigid reliance on knowledge. The authors suggested a restructuring of knowledge across time will aide in stabilizing creative performance. The consideration of time on many phenomena is an important step in investigating the relationship between knowledge and creativity more broadly.

Content Versus Operations

Content

Content refers to the types of knowledge, which can range from industry and task knowledge to more taxonomic types of knowledge, such as schematic and associational knowledge. Researchers have found that the content of knowledge can result in different outcomes for creativity. In a study of 247 undergraduates, researchers investigated the role of content of knowledge (Hunter et al., 2008). Participants were tasked with the generation of solutions for an educational creative problem. Training interventions encouraged the application of different types of content knowledge including associational, schematic, or case-based knowledge. The researchers found that that use of associational knowledge was positively related to the number of ideas generated while the use of schematic or case-based knowledge was positively related to the quality and originality of ideas. Thus, different forms of knowledge content contribute to distinct aspects of creativity.

On the other hand, recent findings also unveiled a link between content and rigidity of thought where the use of associational knowledge can inhibit the production of creative ideas. This can be attributed to the overreliance on existing associations among concepts rather than unique and different connections between concepts across domains. More research is needed to investigate the concurrent use of multiple types of knowledge to further understand these effects.

Operations

In addition to content, operations applied to knowledge also hold significant implications. Operations are thinking strategies that involve combining, elaborating, exploring, and contextualizing content knowledge to form creative solutions. In a study of 155 undergraduates, researchers examined the role of operations of knowledge on creativity (Baughman and Mumford, 1995). Participants were asked to combine concepts from different categories to form novel concepts. The researchers found that the operations of feature search, mapping, and elaboration of ideas contributed to the generation of more highly creative ideas.

Although operations are conceptualized as strategies people use to combine knowledge and form creative ideas, the content of knowledge can also, in return, influence the effectiveness of these cognitive operations. A series of experiments by Ward and colleagues demonstrated this notion, finding evidence that people rely on typical schematic examples of a domain to generate and elaborate upon ideas, even when instructed to be creative. For example, students who were asked to imagine animals on a faraway planet still used familiar attributes of existing animals, such as wings, beaks, or scales (Ward, 1994). Participants who relied less on common examples to generate their ideas showed higher creativity in their drawings and descriptions of new animals and tools. This tendency to rely on familiar examples, however, can be counteracted by combining abstract, rather than concrete, features, or by merging dissimilar, perhaps even opposing, ideas.

Taken together, the strategies that people use to combine information can affect creativity differently depending on the knowledge content. Operations such as feature search, mapping, and elaboration may benefit creativity, but the benefit of these operations may be limited when individuals generate ideas by elaborating from typical examples of a domain. Further, creativity can be fostered by combining abstract or dissimilar ideas instead of concrete or closely related ones. The implications of this research are that the relationships between creativity and knowledge are highly nuanced, and each type of knowledge offers different constraints and benefits to creative outcomes. Accordingly, the following section details specific ways through which knowledge content and operations can hurt or foster creativity.

Knowledge Constraints and Benefits to Creativity

Knowledge as Constraints on Creativity

Constraints from Knowledge Content

One stereotypic assumption about the role of knowledge is that it constrains creativity, most commonly defined as the generation of novel, high quality, and elegant ideas to complex and ill-defined problems. Stemming from research on creativity as divergent and associative thought, this assumption suggests that an overreliance on content knowledge may lead people to recall previous ideas rather than forming new ones (Weisberg, 1999). In this view, researchers argue that creative thought arises from the combination of distally-related information, and dependence on previous, narrowly-focused knowledge may interfere with one's ability to apply new concepts or take different approaches to solve novel and ill-defined problems. Reductions in flexible thinking due to acquired knowledge have often been termed the "cost of expertise" (Sternberg and Frensch, 1992).

To illustrate, in a study of undergraduates solving a social innovation problem, creative thought was inhibited when people were told to apply multiple learned knowledge structures when solving the task (Hunter et al., 2008). Further, a study of 262 benefits broker salespeople that engage in creative selling found that organizational knowledge held a significant negative effect on the relationship between creative selling and sales performance (Groza et al., 2016). It appears that in some cases, learned knowledge can indeed come at a cost to creativity, as it restricts one's capacity to engage in creative thought.

A similar, yet distinct concept to the cost of expertise is the notion of the Beginner's Mind. The Beginner's Mind entails approaching problems with an unassuming and open mindset that is void of preconceived information. Research suggests that expertise can influence the extent to which someone relies discounts new information based on their past knowledge. In a study that examined encoding of information and creativity, researchers found that individuals with higher levels of expertise may falsely assume that previously used information relates to the present problem or discount new information that contradicts their previously learned knowledge (Mumford et al., 2018). This finding confirms past theorizing that knowledge, if tightly embedded in one domain of content, can hinder creativity. Overall, findings suggest that greater domain knowledge and expertise may narrow the breadth of information that an individual applies in creative thought.

Constraints from Operations

A corollary of experts' preference and dependence toward their domain-specific knowledge is their tendency to continue employing knowledge operations that have worked in the past. Experts, then, not only rely on their previous content knowledge to solve novel and ill-defined problems, but they show rigidity in the strategies they employ to innovate. In turn, their persistent use of singular operations can constrain their future creations.

For example, a study of 372 inventors found that inventors who found past success with their innovations were more likely to continue exploiting familiar knowledge to the detriment of future creativity (Audia and Goncalo, 2007). Although successful inventors generated more future patents than less successful inventors, the later inventions of previously successful inventors diverged minimally from their prior ideas. This effect, however, was attenuated when inventors either sought information from others or were encouraged by their companies to explore other domains. The results of this study suggest that continuing to exploit information from the domain in which someone found past success can limit creativity. Yet when the strategy of exploitation is disrupted by external factors that encourage exploration of new knowledge, inventors continued to form divergent ideas. The implication of this

research is that creative success can be found through exploiting a given domain, but continuing to employ the same strategies for later innovations may limit future creativity.

Knowledge as a Benefit to Creativity

Benefits of Knowledge Content

However, other work challenges the cost of expertise and instead supports the notion that creative ideas do depend on one's level of knowledge in a domain. Evidence suggests that, in addition to domain-general creative ability, a person's propensity to generate creative solutions can also benefit from knowledge within a specific domain. Scholars have theorized that the acquisition of knowledge contributes to the repertoire of task-relevant information that people can use to form creative solutions.

Researchers found empirical support for this view in a sample of 187 primary school children (Huang et al., 2017). Students who displayed greater knowledge in mathematics and science demonstrated higher creativity in those domains respectively. Moreover, domain-general divergent thinking ability predicted scientific creativity above and beyond scientific and mathematic achievement, but these effects were not found for mathematic creativity. The results of this study indicate that knowledge contributes to domain-specific creativity in ways that general divergent thinking ability cannot.

Similarly, a study of 183 undergraduate management students found that domain expertise positively related to creative performance on management-related tasks. This finding suggests that creativity within a specific domain benefits from expertise that is relevant to that domain. In other words, expertise ensures that creative solutions appropriately address the problem at hand. The Beginner's Mind, then, may not be useful in situations where people lack the necessary domain knowledge to perform a task.

Benefits of Operations

Evidence also supports a strong positive link between knowledge operations and creative problem solving, where highly creative ideas emerge from individuals who can effectively structure ill-defined problems and evaluate novel solutions. Expertise of knowledge operations enables people to use effective creative problem-solving strategies and avoid ineffective ones. Without adequate knowledge of the operations one could employ in a domain, novices may fail to generate relevant solutions to the task at hand.

In one study on 110 army officers, for example, researchers found that attributes of knowledge structures (i.e., complexity, comprehensiveness, relevance, organization, and diversity) predicted divergent thinking, as well as the generation and implementation of creative solutions (Vincent et al., 2002). Here, distinct applications of expertise were found to improve performance on a number of creativity outcomes, further challenging the view that knowledge hinders creativity.

Another study of 131 young adults compared the evaluative thought and divergent thinking performance of musicians trained in musical improvisation (i.e., a type of knowledge operation), musicians not trained in musical improvisation, and non-musicians (Kleinmintz et al., 2014). The researchers found that musical improvisers tended to rate creative ideas as less deviant or inappropriate than any other group, which led them to produce more original solutions. Knowledge of useful operations thus enables individuals to withhold counterproductive strategies such as evaluating ideas too strictly.

At the core of this view is that individuals with expertise can capitalize and efficiently apply their knowledge to problems at hand. Scholars found that experts can make decisions more quickly, recognize how their knowledge is influenced by context, and can notice smaller details of information than those with less knowledge in a domain (Leonard and Barton, 2014). Several streams of research suggest that, overall, experts make effective and educated decisions surrounding the generation, evaluation, and implementation of ideas. In contrast, novices may lack domain-specific content knowledge and have few problem solving strategies to draw from when generating creative solutions. In sum, expertise may not incur any costs on creativity when it teaches people to think aptly and flexibly within a domain.

The Role of Knowledge Across Operationalizations and Creative Outcomes

Considering the different types of knowledge that individuals possess, and the multiple operations they apply to use that information, it is likely that knowledge affects creativity differently across stages of the creative process. Further, the unique demands and operations required in the creative process may influence the effect of knowledge on different types of creativity. Below is a discussion of the role knowledge plays in various creative operations and outcomes.

Creative Process Stages

Creativity is more adequately conceptualized through process views, where creativity is defined as the result of multiple stages. One common view conceptualizes creativity as a recursive process composed of eight stages, including: (1) problem definition, (2) information gathering, (3) concept selection, (4) conceptual combination, (5) idea generation, (6) idea evaluation, (7) implementation planning, and (8) solution monitoring (Mumford et al., 1991). (See The Four P's of Creativity)

Many studies that examine the relationship between knowledge and creativity explicitly test idea generation or discuss the combination of novel concepts, likened to the conceptual combination stage. In comparison to studies of generative creativity, less attention has been given to the role of knowledge and expertise in other stages of the creative process. Even so, preliminary findings in the realm of idea evaluation suggest that experts are more consistent in their ratings of creativity than novice raters because they have more

knowledge about which ideas are common in a given domain. Overall, more research is needed to investigate the type and level of knowledge as they relate to each creative process stage, as the demands and behaviors at each stage fundamentally differ.

Divergent Thinking Versus Creative Performance

The competing findings on knowledge's relationship with creativity could also be explained by examining how the outcome variable of creativity is operationalized. In some studies, creativity is operationalized as divergent thinking, often consisting of the dimensions of fluency, flexibility, and originality. Other studies examine creative performance, often consisting of the dimensions of appropriateness, originality, and quality.

To address this divide, researchers conducted a study with 143 university students to determine how domain knowledge, among other variables (e.g., general intelligence), predicted creativity as either divergent thinking or creative expert performance (An et al., 2016). The researchers found that while domain knowledge predicted creativity as expert performance, general intelligence predicted performance on a divergent thinking task. Therefore, understanding the effects of knowledge on creativity requires specification about which creative outcome is measured.

Radical Versus Incremental Creativity

Creativity can also be dichotomized as either radical or incremental creativity. Radically creative outcomes are categorized by their exceptional novelty and often paradigm-shifting characteristics. Radical creativity, especially, warrants a strong deviation from previous knowledge, solutions, and thinking in a given domain, often arising from the combination of highly dissimilar information. In contrast, incremental creativity is heavily rooted in previous knowledge in a domain, adding slight novel improvements to existing solutions and ideas over time. The combination of highly distinct knowledge required for radical creativity implies that a strong reliance on domain-specific knowledge may be more detrimental to the generation of radically creative ideas than to the generation of incrementally creative ones. However, it must be noted that expertise still remains a necessary condition for radical innovations in a specific domain.

Team Knowledge

Individual Versus Team Knowledge

Research indicated that when solving a problem, the relevance of information contributed more to the demands of creative thinking than the amount of information. However, to restructure concepts into novel and unique combinations, a diverse set of knowledge is needed and interdisciplinary teams can capitalize on the benefits of both breadth and depth of knowledge. Although individual in-depth expertise has been found to support creative thought, a team of individuals with in-depth expertise in a variety of domains provides a wider and more diverse range of concepts able to be utilized in the generation of creative ideas.

However, researchers recognize that team creative performance is not simply an additive model of individual creativity. Team members need to be both willing and able to effectively share information and knowledge for there to be a positive effect on creative performance. Therefore, teams bring unique challenges centered on group dynamics in the application of knowledge to creative problem solving. (See Teams)

Team Knowledge Sharing

There is limited research on knowledge acquisition in creativity. Above, expertise was discussed in terms of how individuals rely on their own learned knowledge in a domain. However, while working on a collaborative task, individuals can learn from team members as they engage in the creative process and apply new knowledge as a result of knowledge sharing, which has been found to be an important factor for creativity in teams. Additionally, knowledge sharing with members outside of immediate teams can aid in the production of novel and high-quality ideas. For example, biomedical engineers working on a new medical device may need to consult with medical professionals who would eventually be implementing the device in the field. The extent to which individuals can go outside their teams, termed organizational integration and extension, was identified as one of the five core dimensions of an environment that fosters creativity in an effort to establish the core dimensions underlying a creative climate (Heinen, 2018).

Facilitators of Knowledge Sharing

In a study of 350 employees from manufacturing and non-manufacturing organizations, researchers found that leaders foster employee creativity through the facilitation of knowledge sharing between organizational members as well as between their organization and outside members (Carmeli et al., 2013). A study of 198 physicians, psychologists, physiotherapists, nurses, and other healthcare operators examined the role of social capital on the relationship between knowledge sharing and innovative behavior. Findings not only showed a positive effect of knowledge sharing on innovativeness, but also that social capital moderated this effect. Strong ties with others may influence individuals to critically evaluate creative ideas less often resulting in conformity to prevent damage to social bonds (Mura et al., 2013). (See Innovation)

Work on team knowledge sourcing can further delineate how teams can capitalize on and share their collective knowledge. Team knowledge sourcing can be defined as the process of searching for, accessing, transferring, and applying knowledge from each team member as well as knowledge from others outside of the team. This process involves the integration of this sourced knowledge to better understand the problem at hand from the multiple viewpoints available or to combine concepts to form novel solutions that relied on more than one team member's expertise.

Team Knowledge Management

Leaders should emphasize and encourage knowledge sharing with internal team members as well as external sources for effective engagement in cognitive processes associated with creative performance. Additionally, with teamwork comes additional determinants that must be managed for creative performance within teams: team composition, cohesion, norms, groupthink, in-groups and out-groups, risk-taking, and psychological safety (Leonard and Barton, 2014). Leaders should enact practices that capitalize on diversity of knowledge through brainstorming, team knowledge sourcing practices, and the formation of a psychologically safe climate so that team members feel safe to challenge ideas, suggest novel and risky ideas, and to fail without punishment.

Conclusion

This entry summarized research investigating the relationship between knowledge and creativity resulting in two broad conclusions. First, knowledge is essential for generating and evaluating creative ideas. A broad collection of knowledge facilitates the generation of novel ideas because it allows individuals to combine and reorganize distinct information to generate new knowledge. Expertise in a domain also helps individuals understand the relevant context, enabling them to form appropriate ideas and better assess whether certain ideas are truly creative or have been done before. Second, at both the individual and team levels, the relationship between knowledge and creativity depends not only on the type of knowledge available, but also on how it is used. Specifically, knowledge can inhibit creativity when individuals focus too narrowly on familiar information or schemas in one domain. Acquiring and sharing diverse information can counteract the negative effects of knowledge-specificity, and basing ideas on atypical examples of a domain, or combining dissimilar, perhaps even opposing, concepts can result in higher creativity. Thus, when seeking to create, people must consider the types of knowledge they can access and how to use them to best achieve the desired creative outcome.

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Law and Society

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Glossary

Copyright The exclusive right to make a copy of an original or unique work. The entity owning the right may assign it to another.

Creativity The capacity to make new arrangements of thoughts or matter that are original and useful.

Crowdfunding The funding of a creative project by attracting small financial contributions from many people, typically through an internet campaign.

Intellectual Property (IP) A broad term used to describe the products of creative or inventive activity. The use of the term was rare up to c.1980.

Jurisdiction The right or power to administer justice or to enforce laws

Law The rules governing human relations and behaviors; the control enforced by these rules

Limited liability A form of incorporation that restricts the financial liability of any investor (for a company's debts) to the original value of the shares they own

Patent A document that publicly declares the exclusive right of an individual or other entity to exploit an invention (and gain the economic benefit from it). The term derives from the open letter or 'letters patent' issued by a monarch or other authority.

Power The ability to take an action; the ability to force others to act or prevent them from acting

Property Anything that belongs to some individual, group or other entity

Trademark The (registered) words, symbol, sound, smell or color that, in the mind of the public, uniquely identify the source or manufacturer of a particular product or service.

Creative Acts

Creativity may appear in virtually anything, anywhere: in the design of furniture, modes of transport, farming, architecture, clothing, entertainment, communication or humor. A casual witticism among friends and the development of a new technology are both creative acts, but each makes different demands on learning or material resources. The plan for a great public building may be sketched with pen and paper but its construction depends on the infrastructure of a thriving, stable economy, controlled and directed by laws. The greater the degree to which creative acts engage with the material world the more likely are they to encounter the laws of that world: either its natural or human-made ones. A creative idea that exists only in private thoughts is unlikely to be the subject of legal sanction or influence. The interaction between law and creativity therefore represents the interaction between society's rules and some manifest form of creative expression.

Collaborative large scale projects, like engineering or complex technological tasks, demand educated or skilled people and access to considerable material resources. In contrast, a people living in extreme poverty tend to express their creativity in the less material forms of poetry, music or storytelling. We assume three broad conditions for a creative act: the motivation to solve a problem, the inspiration or information needed to devise possible solutions, and the necessary time, expertise and resources to prototype and perfect a solution.

There is no guarantee that inventive capability will work to order. Greek and Roman civilisations understood the power of steam, but found a use for it merely to manipulate large temple doors. It was not until the industrial age of the 18th century that the right combination of technology and economic purpose found compelling applications for steam power: as pumps to extract groundwater from deep coal mines and as engines pulling coal to the smelting works and factories. The more diverse and energetic the pool of ideas on which society draws the more likely it is to find such applications for our creativity. Institutions and law play a part in supporting the conditions and resources for creative enterprise.

Law and Power

law ... constitutes an integral part of the world power process

McDougal (1952)

Power, in its most appropriate signification, therefore, means security for the conformity between the will of one man and the acts of other men.

Mill (1829)

One definition of a law is "a rule of conduct laid down by a controlling authority", which might mean a body constitutionally recognised (e.g. a state government) or one simply having the power to enforce its rules on a community, with or without the explicit consent of the members. To be effective the authority must have the capacity to enforce the laws. Citizens of a state where certain behaviors are accepted may ignore the laws of a state where they are forbidden, unless they place themselves under that state's jurisdiction. The sanctions of law are usually applied on a scale from a trivial fine to deprivation of liberty—or even life. It is important to note that law is not synonymous with morality, equity or fairness. Many nations had laws upholding slavery as a legal condition and, in the present era, some states retain laws that deny women or ethnic minorities equal treatment in education, work and travel.

Laws May Support or Constrain Creative Expression

The ways in which people may express their creativity are made more or less accessible through individual, social, cultural or economic factors. Those factors, in turn, are shaped by the laws of the community, which may allow greater or lesser freedom of expression, and equality in distribution of opportunities and support. For example, laws like the First Amendment to the United States Constitution were designed to safeguard 'freedom of speech' and have been used to protect the ability to carry out creative acts.

Apart from their effect on creativity laws may themselves be creative, in the sense that legislators may invent an entirely novel rule to solve what they perceive as a social or behavioural problem. Present day democratic governments often present new laws as being for the economic benefit or security of the citizens. Justifications include the welfare of a disadvantaged minority, the maintenance of the environment, the good of future generations, or the observance of the laws of a higher (supernatural) moral authority. While the declared object of any law or sanction may be to benefit the community that benefit may not follow, since a law may be poorly designed or—because of unforeseen consequences—may achieve an object at variance, or even contrary, to the one intended.

Laws are Dynamic Not Fixed

As societies mature, develop technologies and become more complex in operation, the rules are refined. Laws may remain fixed for periods of time but they also change to reflect social and cultural views. They are a product of changing perceptions of the quality

and nature of relations with others. Thus, for example, laws governing property rights, including slavery, have changed substantially over the last 500 years.

Creativity Is Disruptive

It seems a reasonable question to ask why laws should ever oppose the creative impulse; however law is a function of power and authority, and creative acts may be seen as a challenge to those. Webster's Dictionary defines 'creativity' as "the process in which original or meaningful new ideas, forms, interpretations or methods transcend traditional ideas, rules, patterns or relationships" (p. 472). Definitions of creativity point to its necessity to replace tradition, thus drawing attention to its disruptive aspect. The status quo may be strongly defended by those interests most disadvantaged by change. The law's function to maintain the status quo sometimes comes into conflict with the iconoclastic impulse of the creative mind.

Creativity is not always fully accepted, or it may even be discouraged and punished by sanctions of various kinds. In some countries it is forbidden to draw the human form, for instance, because it is an insult to a jealous god.

Dimock (1986: 3)

Among countless historic examples Jacobean playwrights like Ben Jonson were regularly imprisoned for sedition, while Beaumarchais's *Figaro* trilogy and Solzhenitsyn's novels were subject to censorship. Any great art movement, such as Cubism, challenges existing conceptions of art. Change is inevitable, but it is also disruptive to the functioning of the society that supplies the food, shelter and resources to support creative projects.

Censorship

Theatre has often been the object of attack by champions of moral probity, either because it was seen as a distraction from 'honest' work or because of its perceived bawdiness. In England in 1642 the Long Parliament ordered the closure of the theatres, depriving the working population of the opportunity to see the theatrical fruits of the English Renaissance by Jonson, Marlowe, Shakespeare and others. The Licensing Act of 1737 and later Theatre Acts (until 1968) gave the Lord Chamberlain the power of veto, a power the holder of that office exercised as late as 1964 against John Osborne's *A Patriot for Me*.

Laws on what is defined (by those in power) as obscenity lead to the repression of books, artworks and films. In 1920 the US Post Office saw its duty under the 1873 Comstock laws as the seizure and burning of copies of a literary magazine containing episodes of James Joyce's *Ulysses* (a book unavailable for purchase in Joyce's native Ireland until the 1960s). Other reasons advanced for restricting the publication or broadcast of literary or artistic works include the protection of children, counter terrorism, public order, and material deemed offensive to race or religion.

Theocracies—as many nations have been throughout history—tend to impose bans on literature or material deemed contrary to the religious beliefs and principles of the rulers, often imposing severe penalties for a breach of the law. States where church leaders are not in control but have significant influence tend to be restrictive about the range of material the public can access. More recently, internet technologies have had a significant role in circumventing some of these restrictions and allowing greater access to creative works and information.

Education

Apart from direct censorship, laws may affect access to information about the world by enabling or restricting education, limiting the distribution of news or other information and constraining the ability to share information or communicate with others. The social value of open access to information is acknowledged in many ways, including the institution of the public lending library, free schools (like the one that educated library philanthropist Andrew Carnegie), and the 'fair use' exceptions and 'public domain' that are an essential part of the intellectual property system.

Writers and artists play with ideas, improvise and create new arrangements of things they have learned. Inventive acts benefit from technical knowledge, the ability to communicate ideas and to carry them through. These all require an educational infrastructure, laws that bring this into being and make it accessible to the greatest number of people.

For a long period formal educational institutions were reserved for the economically prosperous members of society, or for the religious orders. While the great universities began to appear in Europe in the early medieval period these were essentially seminaries for the sons of wealthy families, teaching philosophy (as theology), classics and mathematics. This began to change throughout the 19th century with the decline of monarchies and the growth of quasi-democratic governments in Europe. As enfranchisement grew in scope so did the need to educate the newly enfranchised, at the same time as technologies produced a demand for a broader curriculum that included the sciences and engineering. Elected governments began to recognise the benefit to the state of increasing literacy and of introducing state sponsored systems of general education. This in turn created opportunities, both in education and career opportunities, for the growing educated (middle) class.

Prussia was one of the first countries—in the second half of the 18th century—to introduce mandatory education for all children between 5 and 13. Defeat by the French early in the Napoleonic wars helped to underline the need for improvement. The policy was copied in other places. In Britain the Education Act of 1870 created local education boards, while Acts in 1880 and 1891 made it mandatory for children under 13 to attend school and introduced free primary education. Control began to move from religious factions to the secular authorities. Similar reforms were introduced in France by Premier Jules Ferry in 1881 and such schemes are now the norm.

Laws providing free education for older children and for young adults (third level) were introduced in different countries at different times. The Education Act of 1962 exempted British residents from university fees (until 1998) and introduced a means-tested maintenance grant. The effect of this may be seen in the fact that while in 1913 there were 13,000 students at British universities (from a population of 36 million), by 2016 this proportion had grown to 2.3 million students in a population of 65 million. Likewise the Danish government, with the aim of ensuring education is not based exclusively on a family's ability to pay, pays fees for its third level students along with a monthly stipend for maintenance.

Free third level education is far from universal. While governments everywhere seem to have accepted the idea that free mandatory education for young children is essential, an ideological disagreement remains on whether the state should pay the costs at more advanced levels. The decision seems to revolve around whether higher education is considered by those in power to be a right or a privilege, and whether the benefit is seen to accrue to the individual or to society at large.

One obvious consequence of the growth of a professional educated class has been the increase in the share of national income—as wages—to those with educational qualifications. This has brought an increase in status and respect for the capability and individual contribution of the educated. This increase in access to resources and time has also been responsible for some remarkable creative contributions to society including (but far from limited to) the development of antibiotics, DNA and the technologies of the internet.

Women: Creative Potential Lost

Laws remain in many countries that discriminate against women in terms of property ownership, freedom of movement, education and other opportunities. The struggle by women for full self-expression persists in those countries that make it difficult or impossible for them to operate without male approval.

Virginia Woolf's 1929 essay *A Room of One's Own* imagines an alternate reality where Shakespeare's equally gifted sister, Judith, would have been denied even the relatively limited opportunities available to William, including an education. She might have existed in the drudgery of household chores and eventually been forced into an arranged marriage. In Woolf's imagined narrative Judith's attempts to find expression for her creativity by running away and joining an acting troupe meet with ridicule (since women did not act on the Elizabethan stage) and end in tragedy.

Educational opportunities for women lagged severely behind men. Despite its educational reforms, the Prussian system paid little attention to its separate girls schools or curriculum (Albisetti, 1985), while the United Kingdom had few schools for girls in the 1860s. It was not until near the end of the 19th century that the universities began to open their doors to women students, often in women-only colleges like Girton in Cambridge. The legacy of this unequal distribution of opportunity persists in the record of invention. An examination of United States Patent Office (USPTO) patents from 1994 to 2003 reveals that the proportion granted to individual female inventors may be no more than 5 per cent, indicating an unrealized potential for creativity.

Access to News and Information

It is imperative to have accurate and timely information about the state of the world and current events to inform judgments and actions. For this reason those who wish to mislead the public usually begin the process by hiding or distorting key information. Hence propaganda or 'spin' is frowned on as being the means of manipulating people to approve some faction's desired programme.

The pace of personal communication has quickened, through technologies including signalling, telegraph, and telecommunications. The most recent technology, the internet—particularly when paired with a browser and email equipped 'smartphone'—has been very successful in permitting open communication and relatively free dissemination of information between individuals anywhere on the planet. This has posed a new challenge to authoritarian governments that traditionally suppressed their population's access to information about the world. In some cases the sheer poverty of a country has denied its poorer members access to expensive technologies. Other authoritarian strategies depend on technically blocking access to the Internet, on selection and filtering of content, sites and organisations, and on the deterrence effect of penalties for breach of the laws.

Self-actualization

Maslow's hierarchy of needs often appears in discussions of creativity, usually in the context of our 'peak' need for 'self actualization'—the need to realise potential, including the impulse to create. At the base of Maslow's hierarchy lie fundamental needs: food, shelter and safety that tend to dominate thoughts and actions until they are achieved. Poverty may be a constraint on creative opportunities, since an instability of basic needs diverts attention toward mere survival. Of course even people struggling to maintain the

basics of life still find ways to express their creative impulse. The exquisite Paleolithic cave drawings at places like Lascaux or Altamira suggest that, as soon as the basic necessities of existence have been provided for, people begin to find avenues for personal creative expression, but large scale creative projects require planning, time, experimentation, technical expertise and often great collaborative effort.

Laws that affect status may either enhance the ability to deliver creative projects, or deprive individuals of the autonomy, leisure, and social standing to carry them out. In this category are laws that favor one group over another, or discriminate on the basis of class or ethnicity. For example, the aboriginal population of Australia was denied the vote under the Commonwealth Franchise Act of 1901 “ostensibly because of their limited literacy and command of English” (Cannadine, 2013). Such treatment under the law denies resources and raises barriers against an individual or group’s ability to express themselves.

Class and Social Division

The notion of social order—a natural hierarchy from a monarch down to the lowest class—is embedded in history. This hierarchy was supported by laws to emphasise the distinctions between the classes and their different privileges and obligations. From birth, the lower orders were confined to a narrow range of occupations, most commonly agricultural work. Restrictions aimed at the poor—including laws that tied laborers to their birthplace, punished homelessness, or outlawed vagrancy and begging—denied large numbers of people the opportunity to improve their situation beyond the most basic level of existence.

Debt, Bankruptcy and Financial Penalties

Debt has a dampening effect on innovation. Research shows that the severity of bankruptcy laws significantly affects innovation, as measured by the rate of start-up enterprises (Armour and Cumming, 2008). Bankruptcy declaration is a legal declaration that a debtor is unable to repay their debts and, in more lenient regimes, amounts to a form of debt forgiveness. Those countries with a minimal bankruptcy term prior to discharge (like the United States) enable entrepreneurs to make further attempts at innovation. Armed with the valuable experience of failure people learn to “fail better.” Walt Disney and Henry Ford are among the many beneficiaries of the United States’ lenient bankruptcy terms and limited liability laws.

In a jurisdiction with more severe bankruptcy terms an individual without the financial support of wealthy patrons or family will find the consequences of failure are severe; they will be unlikely to raise sufficient capital for more than a single attempt, or will be permanently deterred from starting any enterprise: “The policy implications are seemingly straightforward: forgiving personal bankruptcy laws and ready access to limited liability offer significant policy instruments for enhancing entrepreneurial activity” (Armour and Cumming, 2008, 337).

Other fixed financial penalties, fines or costs may have very different consequences at different levels of income. Even basic fines may quickly consume the resources of people on lower incomes. As a New York Times article put it: “While a \$250 speeding ticket means little to a millionaire, it’s roughly a week’s pay for someone earning minimum wage” (Schierenbeck, 2018). Likewise, for someone on London’s minimum wage a single parking fine may represent half a week’s income.

Property Rights

The institution of private property rights and the extension of the franchise were important elements in moving from a feudal to an industrial society and a wider distribution of innovative projects. The main argument in favor of private property rights is that they are the most efficient way of exploiting a scarce and valuable resource (land) for the benefit of society, since a property owner is motivated to improve their property through innovation, which ultimately serves the common good. The five personal benefits to the individual of owning large amounts of property were identified by the 15th Earl of Derby in 1881 as political influence, social status, the power to command tenants, rental income and the leisure that income provides (Cahill, 2002: 8). In the past, ownership of property has been a qualification for participation in the political process, one that was abolished in the United Kingdom as recently as 1918.

It is an obvious problem that property is a strictly limited resource and—as populations grow rapidly and wealth aggregates (under heredity laws for example) — the stock of available property is diminishing. Future generations are, on average, less likely to enjoy the benefits of property ownership and—being entirely dependent on wage income—may find themselves in a neo-feudal relationship with a property-owning class (in effect working to pay escalating rent).

Laws may be used to remove some property rights and bring new ones into existence. For example, the ownership of people as property was made illegal in most countries during the 19th and early 20th centuries. In England, from around 1600, a series of Inclosure Acts were used to create property rights for individuals in land previously held by the community in common. In America—in a brief period of thirty years from 1790 to 1820—the indigenous population found that their status as ‘owners’ of the land had been changed to one of ‘occupiers’ in what Banner (2007) describes as a “major change in American legal thought”.

Propertization of Ideas

A surge in the appearance of laws characterizing ideas as a form of property occurred in the 19th century, seemingly as a consequence of the rapid growth of manufacturing industry, as firms better understood that owning inventions and other ‘intangible’ assets could

be highly profitable. The term “intellectual property” (IP) came into vogue around 1980 as a means of attaching the long-established concept of land ownership to the far less clearly defined and often nebulous products of creativity. One important difference is that while real estate is already a scarce good, making property of ideas introduces “a scarcity of the products appropriated which could not otherwise be maintained” (Plant, 1934).

Advocates of the propertization of ideas argue that ensuring the financial benefit to artists and inventors provides an incentive for creative work that the free market fails to provide, proliferates the ideas that lead to progress, and directs capital towards useful projects. Critics of the IP regime argue that a private monopoly on ideas removes opportunities for others to improve on them, blocks some avenues for scientific research, replaces open collaboration with secrecy and antagonistic competition, free-rides on education and research paid for by the public, favors wealthy corporations over individuals and small firms, inflates the costs of essential drugs and important technologies, and proliferates controversial claims of ownership.

The laws governing ideas as property may be broadly separated into the three areas of copyrights, patents and trademarks. The first two of these most concern creativity since they deal with laws that directly protect the right to make copies (of a book, artwork or film for example) and laws that allow inventors to exclude others from using their invention. Trademark registration protects the unique identifying marque or brand of the supplier of a product or service. Unlike real estate, copyright protected works and patented inventions return to the public domain after a fixed term of years.

Copyright

The laws forbidding unauthorized copying evolved to match developments in technologies that facilitate easier reproduction. An illuminated manuscript produced by early Christian or Coptic monks could not, at that time, be reproduced by any means other than the same months of skilled manual work spent in first creating it. With the introduction and improvement of printing technologies after Gutenberg the ability to make copies was greatly enhanced. Digital reproduction is now trivial, and has enabled the almost infinite generation of copies of text, images, film and music.

The presumption of laws to protect against unauthorised copying is that the original creator of a work will not otherwise benefit from the labor involved in creating it. The US Constitution of 1789 explicitly addresses that point: [The Congress shall have power] “To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.”

In England the right to print and publish was controlled for 300 years by the guild of Stationers, the craftsmen who produced pamphlets and texts to sell at their ‘stations’ against the walls of St Paul’s Cathedral. The Stationers’ monopoly and the low fees paid to writers did not make the career of professional author attractive; William Shakespeare’s main income came as a shareholder and actor in the theatre company for which he wrote. After the monopoly of the Stationers’ Company came to an end in 1694 the first true public copyright act, the Statute of Anne in 1710, gave authors some control of their manuscripts for a term of 14 years and raised the prospect of authorship as a profession. Most countries still lacked public copyright laws. In France, until 1789, the *droit d’auteur* was a privilege under the King’s patronage, while German copyright law awaited unification in 1871.

The first international agreement on copyright came at Berne in 1886 at a meeting of lawyers representing the major publishing firms (Ricketson, 1987). Copyright duration terms proposed at the meeting ranged from 20 years to perpetuity, but the term finally agreed was the author’s lifetime plus 50 years (extended to 70 years *post mortem* in the 1990s). In a recent trend media companies facing the problem of copyright expiring on valuable assets have begun to claim trademark rights on as much as possible of the content. Since a trademark right persists as long as the owner continues to use it, the Disney or Harry Potter characters, and everything associated with those, are protected for as long as the corporations that own the rights continue in trade.

The ease of distribution for digital files on the internet raised the tempo of the debate about copyright. The main argument is between those who feel that the internet should remain as open and free as possible and those who seek to be compensated for each instance of the publication of their work. Some copyright holders, led by large media groups, are lobbying government to make internet service providers, like Google or YouTube, legally liable for copyright infringement. Requirements like those in Article 13 of the current European Union’s (EU) Copyright Directive may oblige web services to block uploaded material until its ownership can be determined.

It is impossible to predict the consequences of laws tightening control of copyright material. One possibility is that the public—unable to afford the full price of the better known or heavily marketed artists—may turn their attention to up and coming performers, artists and writers prepared to offer their work for minimal payment through net patronage services like Patreon, or through crowdfunding. Strategies like this are increasingly common on the internet where there is a benefit to early career writers and artists in forgoing payment in favor of broad distribution and rapid exposure. Other models for recovering value for creative work have been proposed, including micro payments, taxation and public subsidy.

Inventions and Patents

The patent originated as a privilege granted by a monarch, usually in the form of an open (patent) letter, giving individual subjects the exclusive right to receive the revenue from some novelty in production, industry or technical method. The issuing of *letters patent* became a means of generating revenue for the Crown, and led to their proliferation and abuse, which the English Parliament addressed in the first patent statute, the 1624 Statute of Monopolies. In the United States the clause in the 1789 Constitution giving Congress the power to promote “science and the useful arts”, was intended to provide a similar monopoly and incentive to inventors “for limited times”.

Laws governing the issuing of patent monopolies rapidly appeared in every country. An important part of the logic for issuing the monopoly was the notion of an exchange. The inventor was given the protected right to solely benefit from their invention for some fixed period, in return for adding to public knowledge by clearly explaining and publishing its detail and methods.

As industry and trade increasingly began to cross international borders during the 19th century international agreements on trade and property rights were needed. Key developments were the 1883 Paris Convention for the Protection of Industrial Property and, in 1994, the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement as part of the Uruguay Round of GATT talks. The TRIPS agreement obliged developing economies to observe the IP rights of the major established economies as a condition of access to international trade. It was a precursor to a succession of subsequent bilateral agreements and free trade agreements strengthening the power of international corporations.

Out of the 300,000 or more new inventions granted patents each year by the USPTO or the EU only a small proportion contain an important novelty or provide licencing revenue. For most individuals or start-up firms the costs of acquiring a patent (and defending it in the rare case when it is infringed) are a burden on their limited resources. In reality the majority of patents today are granted to large corporations with the resources to manage a large patent portfolio and exploit this in multiple ways: as a defensive barrier, to challenge rival firms in court, as bargaining leverage, to exploit tax schemes and loopholes, or as an entry ticket to a promising technology consortium. A large technology corporation like IBM or Samsung acquires over 8000 patents in a single year, in multiple jurisdictions. In sharp contrast the average small firm may acquire fewer than five patents over the firm's lifetime.

Corporations, Power and the Law

Throughout history the effective power to create or amend law has mainly attached to a specific geographic jurisdiction—a national government being the primary example. During the second half of the 19th century large corporations began to develop the power to influence legislation across national boundaries.

The corporation began as a group of individuals joining together to achieve business or social goals beyond the resources of any one member. An important legal change came in the 19th century with society's gift to the corporation of limited liability. Limiting investor's liability to the nominal value of their shares removed most of their risk and allowed firms to attract the capital for large scale and hugely profitable ventures. Corporations have been able to lobby for and influence further legal changes, national and international, including the 1952 US Patent Act which favored the interests of large pharmaceutical firms, and the already referenced TRIPS agreement. Since power and law are closely associated, the modern corporation, with virtually unlimited financial and legal resources, presents an imposing obstacle and deterrent to the individual or small firm in any case involving intellectual property.

Concluding Remarks

This survey of the relationship between law and creativity touched upon the very broad range of factors where the law, at different times and in different ways, acting on individuals and on the community, may affect the capacity to conceive and accomplish creative projects. History suggests that the spread of learning and wide distribution of information are fundamental to enabling and stimulating creative ideas. A community largely reduced to scavenging for food or shelter will struggle to find the resources to engage in great enterprise. A broad and balanced distribution of opportunities and resources encourages diversity and increases the probability of useful innovation.

Creativity benefits from rules that enable a stable society that meets economic and educational needs for most citizens, provides opportunities and resources, and supports innovation and collaborative enterprise. The rules may also be restrictive by favoring interests, obstructing certain groups or sections of society, or aggregating control of resources to a narrow segment of the population. Laws may thus profoundly affect the capacity for a society to be creative.

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Leadership[☆]

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Glossary

Leadership The exercise of influence over others either through behaviors or actions.

Followers Those who work for a leader.

Climate People's perceptions of their work environment.

Mission A tasking given to followers by a leader.

Projects An integrated set of work activities intended to produce a product.

Championing Advocating for resources or support needed to work on a project.

Leadership

Many peoples image of creative people is based on a myth. This myth holds that a genius working alone, triumphs over incredible odds to make a creative idea real or produce an innovative product. Although this romantic myth is compelling, it simply does not have much to do with the reality of creative work.

Creative work in the real-world requires substantial resources. Who will provide these resources? Creative ideas often fail, and sometimes succeed. Who evaluates the success or failure of creative efforts? Creative work typically involves a number of people, often very strong-willed people, with very different ideas. Who will get these people to work together? Many approaches might be used to develop an innovative new product, but who will decide what products and approaches are to be pursued?

These questions are all critical for understanding the success of creative efforts in real-world settings. Examples include the development of transistors, power systems, and space flight. More centrally, all these questions point to the need for effective leadership of creative projects. This entry will examine the key activities that must be executed by those asked to lead creative efforts. Then capacities needed by leaders will be examined, as well as the errors they are prone to make. Before turning to these issues, this entry will examine what is meant by the term leadership and the evidence indicating that effective leadership impacts creative performance in real-world settings.

Institutions, organizations, and firms all represent complex social systems where resources and inputs are transformed to produce viable and valued outputs. Although the production of products and services is often seen as an inherently non-creative activity, virtually all institutions, or firms, are initially based on a new, creative, idea. In fact, the survival and/or profitability of institutions, or firms, is often based on their ability to develop new products or services or adapt extant products and services to changing customer needs. Put differently, creativity—the generation of new ideas—provides the basis for sustained innovation or the development of ideas into viable new products and services.

In firms, or institutions, multiple parties are involved in the development and deployment of any new product or service. In addition, substantial resources are typically required over lengthy periods of time to allow for the development and deployment of these new products and services. Thus, it is usually large, rich, firms that produce radical, new, innovative products. Remember, it was Xerox, not Apple, that developed Graphical User Interfaces. In firms, however, decisions must be made as to what ideas are to be pursued and what resources are to be invested in these ideas. Moreover, multiple people and multiple functional units, such as,

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research and development, marketing, and production, must be marshalled to generate creative ideas and turn these ideas into viable new products or services. In firms, the coordination of various stakeholders, and decisions about investment of firm resources, are commonly held to be the prerogative of those who occupy leadership roles.

Leadership roles require direction of the activities of multiple people, stakeholder groups, or the firm as a whole. Thus, as noted by Bass and Bass (2009), leadership is critical to the performance of firms, work teams, and people working in these teams. The direction of action implies that those occupying these roles must exercise influence. Thus, leadership is defined as the exercise of influence in a social context, where influence can be exercised either through direct actions, such as the leader's interaction with a person they are responsible for (a follower), or indirect actions, such as setting unit budgets or articulating a vision for the firm.

Leadership and Creative Performance

Because creative people need autonomy, some people assume that leaders, by influencing people, inherently inhibit creativity, and, subsequently, innovation. This assumption, however, is perhaps too simplistic. Creative work also requires resources. It requires collaboration and support from others— and, these observations suggest leadership might be critical to creativity and innovation. In fact, Mumford et al. (2019), note the evidence accrued over the years indicates leadership is crucial to the creativity and innovation in real world settings. Consider a few examples.

Barnowe (1975) examined the productivity of 81 research and developments teams, including some 900 chemists. Team creativity was appraised with respect to publication rate, and leader behavior was appraised by team members in terms of leader support for followers, participation, closeness of supervision, and leader technical skill. It was found that these leader behaviors were correlated, in the 0.40's, with evidence of research productivity.

In another study, Tierney et al. (1999) asked 191 chemists working in a research and development unit to describe how positive their social exchange relationships were with their supervisor or leader. Invention disclosures, production of research reports, and senior managers' appraisals of team creativity were measured. It was found that positive exchange relationships were correlated in the 0.20's with these indices of creative performance.

In still another study, Keller (2006) asked scientists, all engineers working in 181 research and development project teams, drawn from five firms, to appraise transformational behavior by team leaders—behaviors such as idealized motivation, individual consideration and intellectual stimulation. In addition, team members were asked to appraise structuring behavior by leaders. It was found that both, transformational leadership and leader structuring behaviors were strongly related ($r \approx 0.35$) to technical creative work accomplished by these project teams.

Not only is leader behavior strongly positively related to creative production, it is related to a number of other outcomes of creative efforts in the real-world. Effective leadership results in:

- Greater investment in, or motivation for, creative work.
- Greater satisfaction with the work being done.
- Better learning, or growth, from the creative work being done.
- Better objective performance—more patents, better schedule performance, and better budget performance.
- The development and deployment of both more incremental innovative products and more radical innovative products.

When one considers these findings, the general conclusion seems clear – effective leadership is a powerful force contributing to creative achievement in the real-world at an individual, team, unit, and firm level.

Leader Activities

Although many extant models of leadership, for example leader-member exchange and transformational leadership, showed leader behavior contributes to creative achievement, these models all seem to result in ambiguities that limit their value as a vehicle for understanding how leaders influence follower creativity. For example, research indicated that while transformational leadership behavior may motivate creative efforts, transformational behaviors also induce dependence on the leader which may act to undermine creativity. Similarly, although positive leader-member exchange may induce feelings of safety, which allows people to undertake creative work, positive exchange relationship may limit the deep criticisms found to be critical to production of more creative problem solutions. (See Teams)

The ambiguities which arise when general models of leadership are used to account for creativity led Mumford and his colleagues (Robledo et al., 2012) to propose a model of leadership expressly focused on the leadership of creative efforts. This model, presented in Fig. 1, holds that the leaders of creative efforts must engage in three global types of activities. They must lead the work, they must lead the people doing the work, and they must lead the firm.

In a test of this model, Vessey et al. (2014) obtained academic biographies of 93 historically notable scientists and engineers. For example, J. Robert Oppenheimer (Physics), Frederick Taylor (Metallurgy), and William James (Psychology), who over their careers led multiple teams working on a variety of creative projects. Judges were asked to code, based on the material presented in these biographies, the extent to which the leader effectively executed each of the key activities specified in this model. These activities included planning, establishing a creative climate, and acquiring requisite resources. Performance was assessed with respect to objective indices such as awards won, number of creative products produced, and article impact, among other indices. It was found

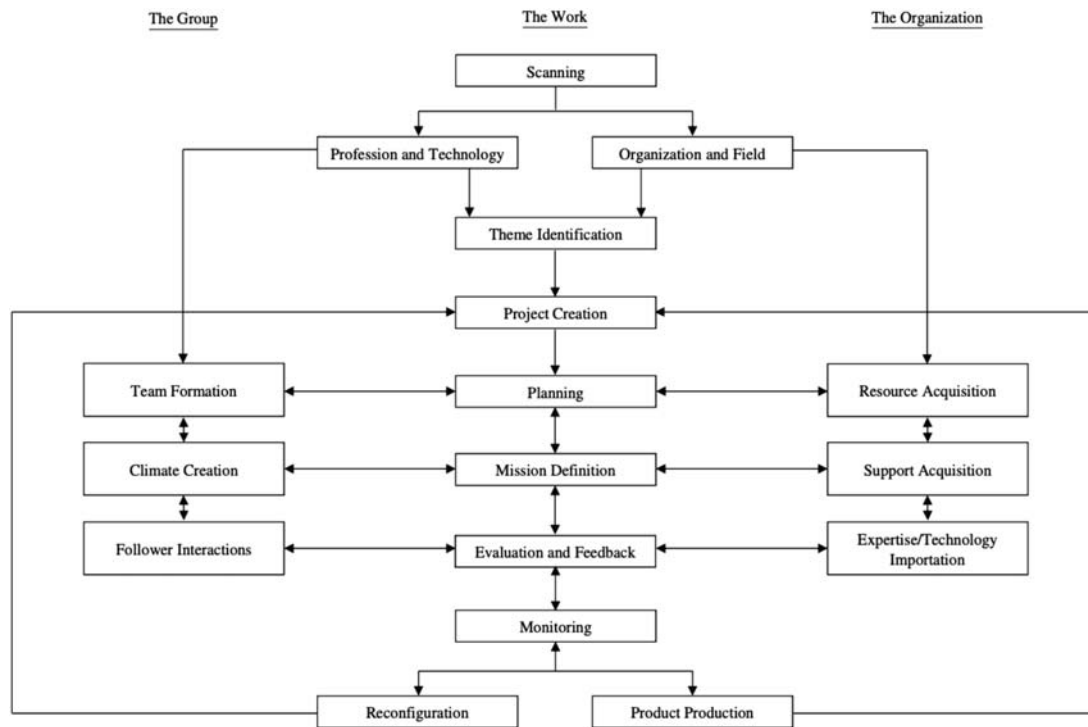


Figure 1 Tripartite model of the requirements for effective leadership of creative efforts (Robledo et al., 2012). Reprinted with the permission of the authors.

that effective execution of these activities accounted for both professional impact of the leader and, notably, the performance of the teams they led. Although additional validation evidence is needed, these findings suggest that Mumford's model may well account for effective leadership of creative teams.

Leading the Work

Creative work occurs in a socio-technical context, which is in constant flux. This observation has a rather straightforward implication—leaders must be constantly scanning their work environment and gathering information about what is going on, who is doing what, and making sense of the information gathered. In fact, many studies showed the quality and intensity of leader scanning activities were positively related to the success of creative efforts. In this regard, however, two key points should be borne in mind. First, leaders often acquire this information from an extensive, perhaps a bit loose, network of contacts. Second, in scanning, leaders must focus on both the professional field *and* the institutional context in which the work is being conducted. Put somewhat differently, leaders must look both inward, to the firm, and outward to the profession.

Scanning provides leaders with a basis for defining key themes to be pursued in project work. From the perspective of the leader, the value of creative work is learning with respect to these themes and development of new products or processes based on this learning. Learning in firms, however, depends on expertise acquired slowly and with great difficulty. Thus, the themes pursued by leaders are not open, but structured with respect to fundamentals—for example Dupont's progressive work on long chain polymers or AT&T's work on communication efficiency and robustness. Leaders establish projects to explore key emerging themes that might pay off in understanding and exploiting a limited set of fundamentals.

A key requirement imposed on those who lead creative efforts is structuring the work to be conducted—a key activity given the novel, complex, and ill-defined nature of creative problems. Of course, effective structuring of project work requires planning. In keeping with this observation Hemlin (2009) has shown that while leaders of creative efforts will delegate many activities, they do not delegate planning. Marta et al. (2005) have shown that leader planning skills are a crucial determinant of the success of teams working on creative projects.

What should be recognized here is that the plans formulated by the leaders of creative efforts are not rigid action steps, rather leaders must envision the future—how work will be conducted and how it might unfold over time. Plans of this sort allow leaders not only to structure work, they also allow for identification and exploitation of emergent opportunities.

Leader plans, however, provide a basis for two other critical activities. First, plans provide leaders with the basis for defining the specific mission to be given to the people doing the creative work. Missions structure people's work without requiring overly close supervision. Second, plans and missions provide leaders with the basis for providing their followers with feedback concerning the work they have executed. Creative people seek contact with leaders early on when defining the parameters within which they are

working, and when seeking evaluative feedback on the work they completed. Thus, evaluative feedback should be technically appropriate with respect to the mission at hand.

Ongoing evaluation and feedback by leaders requires intimate involvement with the projects being pursued. This active engagement in project work allows leaders to actively monitor project work and help followers resolve the many varied crises that arise in the course of any creative project. This monitoring activity allows leaders to reconfigure projects when necessary and bring projects to fielding and production.

Leading the Group

Leader plans are of particular significance because they provide leaders with a framework for identifying what types of expertise, or what types of people, will be needed for a project to unfold successfully. There is not much empirical research examining how the leaders of creative efforts recruit team members. However, qualitative studies have indicated that recruitment of team members is a crucial responsibility of leaders. What should be recognized here is that leaders cannot simply “tell” a creative person to work on a project. Leaders must “sell” the project’s professional significance for the field and advancement of their career.

Once team members have been recruited, their interactions with each other, the project, and the leader will establish a climate. And, it has long been realized that peoples’ perception of their working environment is one of the most powerful predictors of creative achievement (Hunter et al., 2007). What should be realized here is that climate is largely, although not totally, established by the leader.

This brings up a new question. How should leaders interact with followers to establish a creative team climate? Over the years, many dimensions of the work environment have been held to contribute to creative climate perceptions. For example, a positive peer group, supervisory support, opportunities for participation, and playfulness to name a few. Hunter et al. (2007) conducted a meta-analysis study examining the effects of these climate dimensions on creative performance. Although all the climate dimensions contributed to creative performance, three dimensions exerted especially strong effects: 1) challenging missions, 2) intellectual stimulation, and 3) positive interpersonal exchange.

Thus, leaders of creative efforts must encourage people to actively think about the mission at hand, challenge them intellectually, and encourage people to work together to address these challenges. Of course, given the nature of creative people, this may prove more difficult than it might appear. Thus, leaders may use a variety of tactics to establish such an environment. They may encourage all to contribute in project meetings. They may ask team members to present anticipated next steps for team review. They may encourage public dissemination of project work with all contributors being listed as authors.

Establishing a creative climate is of value for another reason, it provides a context for positive leader-follower interactions. Positive leader-follower interactions allow followers to feel safe in their work and trust both the leader and other colleagues. Positive interactions, however, are not simply a matter of the leader being pleasant. Rather, leaders must help creative people do their work and respect the value of the work that they are doing. Thus, leaders must serve not only as a mentor, but as a senior technical advisor and sounding board for followers as well.

Leading the Organization

Leader plans are not only central to leading the work and recruiting followers. They are also central to obtaining the resources required to pursue creative projects. The available evidence indicates that top management support for creative projects, support providing adequate, sustained, resources and establishing the legitimacy of the creative effort, is a critical determinant of project survival and success. It is the leaders of creative efforts who must recruit this support from top management. In other words, leaders must sell, or champion, the creative efforts they envisioned.

Howell and Boies (2004) examined what leaders need to do in order to champion their projects to institutions. They obtained 19 pairs of matched product champions and non-champions working in information technology firms fielding 28 new products. These champions were interviewed, and interview transcripts were content coded. It was found that product champions both packaged ideas and sold those ideas. Effective packaging and sale were found to depend on normative knowledge, or understanding of the firm’s business process, and contextual knowledge, or understanding of the firm’s business strategy. In other words, leaders of creative efforts must know the firm, and its strategy, in order to sell ideas and acquire requisite resources.

Leaders, however, must do more than attempt to garner top management support. They must also build support among other key stakeholders in the firm—new projects must be built (manufacturing) and sold (marketing). Notably, if key stakeholders do not support an effort, even if top management does, it will fail. Moreover, at certain points as projects unfold, staff must be recruited from, and infused into, creative teams. Although such cross-functional teaming arrangements are known to contribute to the success of new project development efforts, cross-functional teaming is unlikely to occur if relevant institutional stakeholders will not support the creative effort.

These observations are noteworthy because they imply that leaders of creative efforts must do four things. First, the leader must build personal connections to key people in each stakeholder group. Second, they must understand the implications of the creative effort for routine operations in the stakeholder group. Third, they must educate the stakeholder group as to the implications of the creative effort. Fourth, they must help the stakeholder groups address problems raised for them by the creative effort. Thus, those asked to lead creative efforts must also become teachers.

What should be realized here is that such instructional activities provide leaders with an understanding of who in different functional units has expertise that might prove of value to creative teams. Thus, such actions provide a basis for importing expertise into creative teams. By the same token, the reactions of creative teams to these “imports” may not be positive—they come from different fields, have only a limited history with the project, and often will not know project staff. Thus, leaders

must clearly articulate to team members why new staff have been brought aboard and how they will be expected to contribute to project work.

Leading Capacities

When one looks at the key activities required of those asked to lead creative efforts a new question comes to fore. What capacities must leaders possess to execute those varied activities effectively? One key capacity is implied by the need for leaders to plan creative projects and provide people with feedback concerning their creative work. The leaders of creative efforts must themselves possess substantial creative thinking skills. In fact, [Zaccaro et al. \(2015\)](#) showed that the extent to which leaders possess creative thinking skills, problem definition, conceptual combination, and idea generation skills, was a crucial determinant of both leader and team performance when working on tasks requiring creative problem solutions.

Along with creative thinking skills, however, leaders of creative efforts must have substantial planning skills. In fact, the [Marta et al. \(2005\)](#) study indicated that planning skills may be critical to effective leadership of creative efforts. In this study, teams were asked to formulate plans for turning around a failing automotive company. These plans were appraised for quality, originality, and elegance. Team members nominated leaders and all participants were appraised with respect to planning skills and structuring behavior. The most creative solutions were obtained when team leaders evidenced strong planning skills in part because these skills contributed to better task structuring.

The importance of planning skills points to another capacity that must be possessed by those asked to lead creative efforts. The kinds of plans one formulates in one domain are different than those needed in other domains. Thus, it is reasonable to assume that those asked to lead creative efforts must possess substantial expertise. In fact, prior studies showed that creative people will not accept influence attempts unless the influence attempt is expertise based. In other words, influence must be exercised with respect to the work to be done. Not only do the leaders of creative efforts need substantial technical expertise, they must also have expertise with regard to the organization, and its operations, if they are to acquire support and lead the firm in a creative undertaking. These observations are of some importance because they imply that the old myth that leaders do not need expertise, they just need to know how to lead, does not apply in the case of creative efforts.

Creative thinking skills, planning skills, and expertise are all distinctly cognitive capacities. Leaders of creative efforts, however, will also need substantial social skills. Social skills are needed to establish the networks used by leaders in scanning and to establish relationships with other units in the firm. Social skills are also needed to establish a viable team climate and provide people with feedback concerning the work being done. Prior studies have shown one key difference between the leaders of creative efforts and high performing creative people is that leaders demonstrate substantial social skills. In this regard, however, it should be borne in mind that the social skills needed by those asked to lead creative efforts are not simply a matter of being friendly—Leaders, at times, must provide critical feedback. Moreover, leaders of creative efforts must be skilled at appraising others, they must be able to monitor the interactions among team members, and they must be able to regulate their own, and others', emotions—arising from the various crises that emerge in the course of any creative effort.

Beyond social skills, leaders must possess one other capacity likely to prove to be an important influence on performance. Creative efforts are inherently ambiguous, and in any firm, the concerns at hand are not just the success of the creative effort, but its impact on and value to the firm. Leaders, as a result, must be aware of, and be able to balance, these pressures as they guide the development of creative products. Leaders, moreover, must be able to appraise the fit of a creative effort to both the needs of the firm and the profession, taking into account relevant risks and payoffs. As a result, it seems clear that those asked to lead creative efforts need wisdom. A study by [Connelly et al. \(2000\)](#) showed that social judgment skills linked to wisdom are strongly, and positively, related to performance in the leadership of creative efforts.

Leader Errors

The need for wisdom points to a key error often made by those asked to lead creative efforts. When people are presented with new ideas, they are evaluative, critical, and seek to identify the deficiencies evident in the idea presented. [Loneragan et al. \(2004\)](#) asked people to assume the role of a leader in a marketing firm appraising advertising programs of known quality and originality under innovative or efficiency standards. They found that the most creative products emerged when high-quality ideas were appraised with respect to innovative potential, and when highly original ideas were appraised with respect to efficiency. Thus, leaders of creative efforts must compensate for deficiencies in ideas, not just criticize the ideas produced. Indeed, harsh, non-compensatory evaluations may act to demotivate creative people and undermine the engaged, intellectual, climate needed by creative work.

Leaders of creative efforts, moreover, cannot evaluate just the idea as it stands. Leaders must be able to envision how this idea will unfold over time, both within the profession and within the firm. Put differently, leaders of creative efforts must be able to forecast downstream. Both, qualitative studies of the development radical new innovations and empirical studies of performance in leading creative efforts indicate that extensive forecasting is critical to leader performance.

Like the people doing the creative work, the leaders of creative efforts have much invested in the creative work that has been accomplished. Creative leaders “love” their creative products. This results in a tendency of leaders to try to protect the product they, and their team, produced. The problem that arises here is that as ideas move from initial development to fielding, many

changes must be made. If leaders seek to protect the integrity of the idea, at the expense of the needs imposed by fielding, performance will suffer. The errors arising from idea protection will be more likely if the leader isolates themselves, or the project team, from contact with other units of the firm or other stakeholders. Prior studies indicate that successful leaders of creative efforts take actions to minimize the negative effects of isolation on creative teams.

Lack of compensation, limited forecasting, and protection of sunk costs in ideas one has worked on are endemic sources of error in all humans. Leaders, due to the nature of leadership roles, are prone to make two distinct types of errors. One error is associated with the need for deep processing and one error is associated with the need for ongoing learning.

In firms, leaders must do many things—attend meetings, complete forms, track budgets—and, as a result, leaders lack time and are under substantial pressure. Thus, leaders often simply try to move through things and get them out of the way. This work strategy, of course, undermines depth processing—leaders often believe they can not dwell on things. Creative ideas are novel, complex ideas with many implications. As a result, failure to process ideas deeply will undermine leader performance. In fact, there is reason to believe that unless leaders think about ideas deeply, they will not ever see the potential value in a creative idea. This point is noteworthy because it implies that leaders must use work strategies, such as time blocking, that give them time to think deeply about the ideas that they are being presented with.

In firms, leaders are also under intense production pressures. Firms want success and they want creative work to be done in a cost-efficient fashion. Creative efforts, however, often fail and failure, to the leaders of creative efforts, is not necessarily a problem if the leader, the team, and the firm learn from failure. However, the pressure for production may cause leaders to lose sight of the need for ongoing learning as they pursue creative projects. By devaluing learning, the long-term success of creative efforts will suffer, resulting in errors. By the same token, these observations imply that leaders must find ways to maintain their curiosity, even as they grapple with substantial production pressures.

Conclusions

Leadership of creative efforts may be among the single most demanding forms of work any leader is asked to do. It may, in fact, be harder to be the Research and Development Director than the President of the firm. To effectively guide creative efforts, leaders must lead the work, the team, and the firm—three distinct activities which must be integrated. To execute these activities, leaders must do many things. They must constantly be scanning their environment, they must be able to plan projects, they must provide viable feedback, they must establish a creative climate, they must sell, and they must teach.

To complicate matters further, if they are to lead these efforts successfully, they have to avoid common mistakes. They cannot just evaluate, they must compensate. They have to look downstream. They have to think in depth, and continually learn, even as they cope with substantial production pressures. They must be technically skilled, experts in their field, but they must also know people, and the firm in which they're working.

These many substantial demands have a noteworthy implication. The leaders of creative efforts, at least successful leaders, don't just appear by magic. Systematic efforts, long-term, appropriately scaffolded developmental programs, must be put in place to prepare people to lead creative projects. The hope is that this entry provides an impetus for future work intended to establish exactly how to prepare people to become the leaders of creative efforts.

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Learning Differences

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Glossary

Cognitive style A pattern of thinking with which an individual processes information that is independent of context.

Growth mindset Learners are capable of adapting their learning and are not fixed in their ability to learn.

Learning difference The diversity exhibited by learners when engaged with material, processing the context, and understanding the information.

Learning disability A legal qualifier to ensure a student has access to educational resources to meet learning accommodations.

Learning style An individual's preference for perceiving information that interacts with the environmental context.

Meshing hypothesis Matching the individual's unique learning style with the mode of instruction or curriculum will achieve optimal success.

Overview of Learning Differences

Human creativity is a complex and diverse attribute. Learning differences, which is an umbrella term that includes both learning disabilities and learning styles, as well as the method with which individuals perceive, process, and remember information contributes to this diversity.

Learning Differences

Learning disabilities and learning differences are often used interchangeably in the field of education and psychological sciences but there are important distinctions between the two. In the United States, a learning "disability" is a legal qualifier in the Individuals with Disabilities Education Act ("IDEA") and Section 504 of the Rehabilitation Act. These are federal mandates that protect the rights of students between the ages of three and 21, and provide mandated special education services. To receive these resources, a student must exhibit one or more of the thirteen qualifying learning disabilities which include autism, blindness, deafness, emotional disturbance, hearing impairment, intellectual disability, multiple disabilities, orthopedic impairment, other health impairment, specific learning disability, speech/language impairment, traumatic brain injury, or visual impairment. The learning disability must affect the student's academic performance leading to the need for specialized instruction from an Individual Instruction Plan (IEP). Similarly, the civil rights law Section 504, provides accommodations for students with disabilities that impact learning. The recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM) provides diagnostic criteria for Learning Disability which includes dyslexia, dyscalculia, and difficulties with reading fluency or comprehension, and problem-solving. Learning disabilities are fairly prevalent, impacting about 5% of American students in a variety of areas including reading, math, writing, speech, and executive functioning terms.

By contrast, a learning difference is not a diagnostic term and does not usually appear in neuropsychological/psycho-educational evaluation nor on an Individual Education Plan. Instead it is an umbrella term for several subcategories that impact learning. These subcategories typically include learning disabilities and learning styles. Much of the early attention on the connection between learning differences and creativity has been generated from historical evidence. While learning differences can impact academic performance and daily functioning, the result is not always detrimental.

Anecdotally, the positive impact of learning differences on creativity and problem solving has been demonstrated by reviewing the achievements and inventions of several creative geniuses who achieved greatness in a variety of fields such as art, music, physics,

and writing. Many of these renowned experts exhibited high levels of creativity, which is defined as “the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context” (Plucker et al., 2004, p. 21). Successful creativity and problem solving requires understanding the task, drawing on knowledge from long term memory, divergent thinking, synthesizing, and evaluating the ideas. Creativity therefore, is not immune to being influenced by learning disabilities.

There are many examples of successful individuals who had or may have had learning disabilities. For example, singer, songwriter, and co-founder of the Beatles in the 1960s, John Lennon excelled in music and songwriting but also had a history of academic struggles, poor concentration, and inventive spelling, which many believe was attributed to undiagnosed dyslexia.

Einstein, who greatly excelled at visual and spatial creativity, is believed by many to have had Asperger’s syndrome and dyscalculia. Both of these learning disabilities may have created a hyper focus in visual and systematic areas in mathematics and physics thus allowing him to visualize complex mathematical patterns differently than his peers.

Temple Grandin, originally diagnosed as brain damaged and subsequently with sensory processing disorder, is now believed to be on the autism spectrum and greatly excelled in science and photo-realistic visual thinking. She went on to become the first inventor to design a calming device to reduce sensory overload for those with autism and was the first scientist to report that cattle are prone to sensory overload. Grandin developed a series of new techniques to promote the humane treatment of cattle.

While parallels can be drawn between learning differences and creativity retroactively among creative geniuses, they are problematic for two main reasons. First, any association drawn lacks scientific control and, in any observation of posthumous historical figures, misinformation, assumptions, or even observer biases may lead to inaccurate conclusions. Second, the focus on creativity is limited to highly successful, renowned experts. This is not surprising as much empirical research on learning ability and creativity has primarily addressed above average ability and gifted learners. For that reason, attention to the diverse impact of learning differences is an important area of work as it focuses on the learner, the environment, and the context to determine the optimal environment needed to promote success in learning, problem solving, and creativity.

However, it may not be a coincidence that many creative geniuses exhibited dyslexia, dyscalculia, autism, or Asperger’s Syndrome as these learning differences are among the most prevalent learning disabilities. Dyslexia is perhaps the most studied learning disability in its relation to creativity and problem solving. It impacts an individual’s ability to decode phonemes, read fluently, and comprehend text passages.

Much of the research on the impact of dyslexia and creativity has focused on adult populations using divergent thinking tests such as the Alternative Uses Task. This assessment prompts the test taker to list as many ideas for common household objects such as a paperclip or newspaper. The responses are then scored for several qualifiers such as fluency (the number of ideas), flexibility (the different types of ideas provided), originality (responses that are statistically rare), and elaboration or expressiveness (the amount of detail in the response). Because these assessments tend to be verbal in nature and often timed, any learning difference that inversely impacts memory, writing, or executive function would likely negatively impact subsequent performance.

Additional assessments that include figural components, can avoid the verbal influence by providing an alternative measure of creativity that requires the individual to complete a series of incomplete figures or generate ideas to an abstract image, or improve a toy design. Similarly, both Holland’s Creativity Activity and Accomplishment Checklist and the Creative Behavior Questionnaire provides a list of verbal creative activities such as “I have had a piece of literature published”, and nonverbal activities, such as “I have made jewelry”. The respondent then reports the frequency of engaging in those behaviors.

The research findings on the impact of dyslexia on creativity are what would be expected. Those with dyslexia may exhibit reduced verbal creativity but there is no reduction in figural creativity. Children who exhibit signs of dyslexia not only may have impairments in verbal tasks such as reading and writing but may also struggle with mathematics. Dyscalculia, which is the difficulty in understanding and manipulating numbers, math formulas, and interpretation of visual data in graphs, exhibits a high degree of comorbidity with dyslexia. While there is little research on the sole impact of dyscalculia on creativity, it is generally believed that because dyscalculia impairs number retrieval and estimation of basic calculations, advanced calculations required in the field of mathematics and physics may be immune. This is the reason some children who struggle to succeed in everyday classrooms go on to astound onlookers with their creative ability in those fields.

Another prevalent learning disability, autism, is a neurodevelopmental disorder in which an individual exhibits impaired social interaction, limited communication, and has a restriction of activities that are often repetitive in nature. While a diverse spectrum of characteristics exists, a subcategory, generally viewed as high-functioning, is Asperger’s Syndrome (AS). Similar to characteristics found with autism, those with AS may exhibit a preference for restriction and repetition of an all-absorbing interest in a specific topic. While this drive for systematization may reduce imagination it can be a valuable attribute in creative problem solving by producing more detailed concrete and realistic ideas.

Though research on learning disabilities tends to focus on impairments or weaknesses, research on learning differences tends to focus on the benefit of cognitive diversity in thinking and problem solving that may be different from typical individuals.

Learning Styles

While not a diagnosable learning disability, learning styles, a subcategory of learning differences, refers to the preference of material to provide optimal learning for an individual.

Learning styles are typically viewed as an individual's predisposition for perceiving and processing information in specific ways. Generally viewed as a consistent trait, it is believed that once a learning style is identified, educators can present material conducive to the learner's style in order to facilitate encoding, recall, problem solving, and creativity. While learning styles interact with the content and material, they vary from person to person. In contrast, cognitive style refers to a pattern of thinking that is independent from the content.

Historically, the initial research and test development for learning styles was conducted in the 1980s by David Kolb who speculated that students exhibit different and consistent preferences for learning activities. Developing the first assessment, the Learning Style Inventory (LSI), he theorized four types of learning styles within the experiential learning process. These four styles fall into a quadrant that contains two dimensions. The first dimension focuses on thinking such that individuals exhibit a preference of either active thinking or reflective thinking. Those who prefer to be active will initiate their assignment by writing, calculating, or designing as the project unfolds. In contrast, those who are reflective prefer to have the entire assignment and an outline of the project before generating their response. The second dimension refers to the information. Individuals either prefer to have concrete information or abstract information. Those who prefer concrete information want to process each chunk of information in meaningful, individual pieces, whereby those who are abstract view the assignment in global terms. These two dimensions then create four quadrants: *accommodating style* (concrete and active), *diverging style* (concrete and reflective), *converging style* (abstract and active), and *assimilating style* (abstract and reflective).

Those with **accommodating** style prefer organized rules and step-by-step instruction with less attention on theory as typically found in business organization and managerial fields. Their form of creativity would be most pronounced in a design aspect of planning and organizing that includes gathering background information and outlining goals. They excel in generating a unique method of organization. Those with **diverging** style tend to excel on brainstorming activities and imaginative. Their form of creativity would be evidenced in generating many unique and original ideas as they prefer learning with interpersonal communication and group projects typically found in journalism, group discussion, competitions, and role play sessions. In contrast, those with **converging** style prefer convergent thinking and are solution driven. They prefer learning routine and well defined problems that have clear expectations that yield a single correct answer typically found in gathering statistical information and generating models. Their creativity would be witnessed in adapting formulas or generating new rules in the field. Those with **assimilating** style tend to excel in synthesizing information. They prefer ill structured problems that have unclear methods, unknown rules, and require insight to reach solutions typically found in the sciences or engaging in creative problem solving. Their creativity is most likely found in altering the field by driving it into a new direction.

While Kolb focused on individual learning preferences and suggested that teachers should develop lesson plans to suit individual learning styles, he pointed out that the optimal learning curriculum, would contain all four quadrants (See Fig. 1) whereby an individual generates a plan (accommodating), gathers information (diverging), integrates the information (converging), and reflects on the solution to then make adjustments as needed (assimilating). This curriculum is witnessed in many contemporary paradigms such as brainstorming and problem based learning).

Perhaps one of the most popular learning styles is the Visual, Auditory, and Kinesthetic (VAK) learning style model proposed by Dunn and Dunn in 1970s (Dunn and Dunn, 1972).

Praised for its simplicity, the VAK, proposed that, while learner's may exhibit all three types of learning style, only one of the three types of preferred learning is dominant.

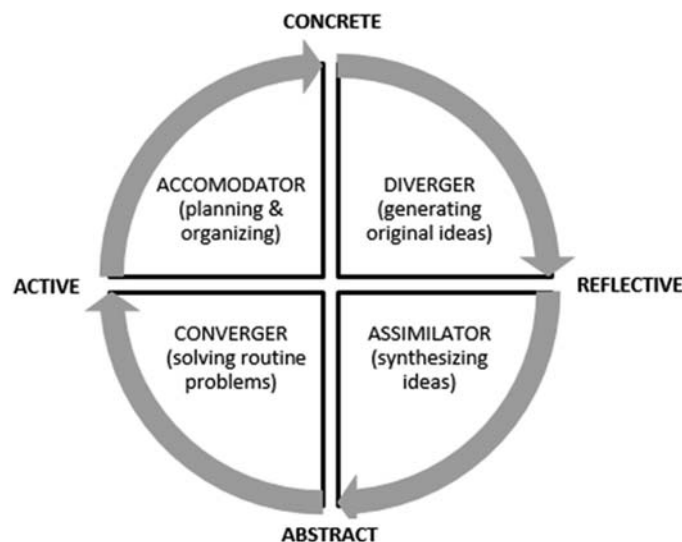


Figure 1 Interaction of the four components of Kolb's learning styles model.

Those with **visual** style prefer seeing visually with information presented via illustrations, charts, diagrams, and formulas. Visual learners excel when instructions and directions are written rather than spoken and are able to recall visual information (such as faces after an introduction) at higher rates. They often create mental images, tend to think in pictures, enjoy doodling and color coding, and are more perceptive to changes in the visual field. Their creativity is most likely demonstrated in writing, drawing, and visualizing complex patterns of data as well as three-dimensional tasks such as architectural and design. To promote creativity, presentation of and interaction with visual information that includes design features (colored coded graphs or computer design programs) are recommended.

Those with **auditory** style prefer hearing information that is presented via lectures and discussions. Auditory learners excel when instructions and directions are read aloud rather than written and are able to recall spoken information (such as names after an introduction) at higher rates. They may whisper aloud while reading and tend to enjoy the phonemic patterns found in rhymes and iambic pentameters. Their creativity is most likely demonstrated in poetry, musical performances, debates, group discussions, or presenting speeches. To promote creativity, interactive discussion sessions and environments that permit reasonable noise levels are encouraged.

Those with **kinesthetic** style prefer information that is tactile from dance, movements, or touching and excel when they are fully engaged in the task and instructions are physically shown. They are able to recall proprioceptive information (such as gymnastic routines or dance moves often after only one demonstration) at higher rates. They often put their bodies into the work to create physical routines. Their creativity is most likely demonstrated in movement such as hand-on activities as well as four-dimensional tasks such as dance choreography, drama presentations, martial arts, athletics, and science projects. To promote creativity, props and hands-on interactive activities as well as an environment that allows movement is encouraged.

Updates to this model include the VARK (Fleming and Mills, 1992) which maintain the visual, auditory, and kinesthetic, but includes the addition of reading/writing. Those with **reading/writing** style prefer interacting with text via book and video. Reading/writing learners excel when instructions and directions are printed and are able to process and remember information that they actively read. Their creativity is most likely demonstrated in word play, poetry, and writing.

Embedding the VARK in education and curriculum planning, proponents of this learning style propose that age related changes interact with learning style such that young children in preschool and early elementary school tend to be kinesthetic (touching objects and benefitting from hands-on learning that includes movement). As they continue into later grades elementary school (i.e., age 8) they transition to become visual learners and benefit from printed material and illustrations. By middle school (i.e. age 12) they may become auditory learners as they generate mental frameworks from spoken instruction.

Another model proposed by Felder and Silverman (1988) delineated learning styles into four domains: **perception** (the interaction of the learner with the information in either sensory or intuitive), **input**, (preference for external information visual or verbal) **processing** (either active or reflection), and **understanding** (either sequential or global). Each component within the Felder-Silverman learning style model (FSLSM) corresponds to recommended teaching styles such that *perception* requires teachers to provide content in either concrete or abstract. This would foster creative expression that is either literal, and follows a prescribed pattern, or theoretical and innovative, and follows, as of yet, unknown paths. *Input* requires presentations in either visual or verbal forms that correspond to creativity expression in printed visual forms such as drawing or diagrams or verbal forms through poetry recitals or speeches. *Processing* requires students to be active or reflective in their participation. Creative expression would result in a generation of novel ideas or products or a reflection and connection of ideas to previously established concepts. And lastly, *understanding* requires the teachers to provide information in a manner is either sequential or simultaneous. Creativity is expressed through a sequential nature may be a mathematical formulas while creativity expressed through a simultaneous form may be pattern recognition. Felder and Silverman's Index of Learning Styles (ILS) was subsequently designed and has been popular in both education and technology design to promote learning, problem solving, and goal setting. Presenting information simultaneously rather than sequentially generally improves creative performance.

In line with the theory that there are multiple learning styles, Gardner's developed his well-known multiple intelligences during the 1980s. Outlining eight distinct intelligences provides insight into how student process and interact with information to generate a creative idea. Similar to the verbal style in VAK, those with **linguistic** intelligence excel by interacting with world with through writing or speech. They prefer to take written notes of spoken information and thinking often think in textual words rather than images. Their creativity would excel in synthesizing written information, writing, and creating poetry or writing stories. Similar to the visual style in VAK, those with **visual-spatial** intelligence are skilled at processing and interacting with information that is presented visually such as formulas and diagrams. Their creativity is most pronounced in visual art, pattern recognition, and they are apt at mental rotation tasks. Those with **logical-mathematical** intelligence excel in activities that require scientific reasoning and calculations often found in conducting scientific experiments. Their creativity can be witnessed in solving analytical problem or generating novel experiments to test theories. Similar to the kinesthetic style in VAK, those with **bodily-kinesthetic intelligence** perform better with hands on activities and express their creativity through coordination and movement such as dance, acting, and athletics. Those with **musical** intelligence are tuned into sounds in their environments and excel in musical composition and recognizing pitch and tone. Those with **interpersonal** intelligence have heightened cognitive and affective empathy and are capable of understanding other people's emotions. They excel in character development in writing and in group dynamics such as communications and diffusing intergroup conflict. Those with **intrapersonal** intelligence excel in self-reflection and identifying their own emotions. They perform best through writing, introspection, and reflection.

Connecting Learning Styles to Creativity

Creativity and problem solving is witnessed in many domains including the obvious fields such as art and music but also the less obvious ones such as STEM (Science, Technology, Engineering, and Mathematics). Therefore, there are strong parallels between learning styles and promoting problem solving and creativity in many fields. Employing Kolb's theory, creative expression is fostered by promoting multiple active thinking processes such as divergent and convergent thinking. In contrast, in both the VAK and VARK models, the learning styles result in creative products such as poems or dance.

Synthesizing both the process and the product while drawing heavily from the fields of engineering and science, Felder-Silverman's learning style model promotes creativity through following math formulas to generating new math theories. Gardner's (1983) theory promotes several subfields of creativity and creative expression from dance to imagery (See Fig. 2).

Controversies

Aligning teaching styles to learning styles is a popular approach. For example, some individuals considered to be visual learners may benefit from having information presented visually and may exhibit a reduction in performance if information is presented mainly in an auditory manner (Kolb, 1984). In fact, it is because of this conventional wisdom that learners exhibit predispositions for various learning styles, that many current classroom practices provide students with a variety of verbal, auditory, and visual information. It is thought that by providing all three media modalities will enhance learning in a group setting by accommodating those various types of learners (i.e., provide text, auditory, and visual information to address all possible types of VAK learning styles). Furthermore, one might theorize that a student's learning style (preference for textual information over visual information or vice versa) would predict individual differences in performance. For example, if students are visual learners they should perform better when information is presented via graphs and diagrams, whereas if students are auditory learners, they should perform better when information is read aloud.

An extension of the older scaffolding hypothesis and "the problem of the match", the Meshing Hypothesis or belief that educational curriculum, when matched to a learner's corresponding learning styles will promote success is so ingrained in classrooms that most accept it as fact. However, much of the theories addressing learning styles come from observations in the school setting rather than scientific research experiments. As a result, when tested with controlled empirical experiments, learning styles does not hold up to scrutiny. While learners often have clear preference for information, those preferences have little, if any, impact on their actual learning. A meta-analysis of studies assessing learning style suggests that student's achievement levels may not benefit from matching the style of an instructional technique to their preferred learning style (Stahl, 1999) and further research fails to support the idea that learning styles promotes actual learning. Perhaps most critical was Coffield's et al. (2004) analysis of 13 popular learning styles to review the reliability and validity of each model. They found poor reliability and validity in the measurement as well as limited benefits of employing any learning style on subsequent academic performance. This same lack of benefit has been established for creative performance.

Author	Learning Style	Concept	Creative expression example
Kolb (1984)	Learning Style	accommodating style	concept mapping
		diverging style	brainstorming
		converging style	convergent thinking
		assimilating style	synthesis
Dunn & Dunn (1972)	VAK	visual	graphic design and art
		auditory	rap music, poetry recital
		kinesthetic	dance
Fleming & Mills (1992)	VARK*	reading/writing	creative writing, journalism
Felder & Silverman (1988)	Felder-Silverman learning style model (FSLSM)	perception	instruction and developing theories
		input	flow charts or speeches
		processing	recipes and innovation
		understanding	math formula and pattern recognition
Gardner (1983)	Multiple Intelligence	linguistic	creative writing, journalism
		visual-spatial	imagery and mental rotation
		logical-mathematical	analytical problem solving
		bodily-kinesthetic intelligence	dance, athletics
		musical	musical performance or composition
		interpersonal	communication with others
		intrapersonal	self-reflection

*includes VAK

Figure 2 Overview of Popular Learning Styles.

Based on these conclusions, it has been recommended to discontinue the use of the Meshing Hypothesis and not embed learning style models in the classroom. Yet, even when armed with this knowledge, 15 years later, learning style theories still remain the most popular myth among both teachers and the public.

There are several concerns about the continued use of the meshing hypothesis to design educational curriculum. An obvious concern is the continued use of non-scientific based practices. A second concern is the knowledge that creativity is best fostered by addressing the *domain specific learning* rather than an individual's learning style. With the knowledge that creative problem solving is domain specific, educators should generate curriculum based on content, not learner's preference. However, most content is rarely conducive to one modality, so a thoughtful combination of multiple modalities is recommended. A third concern is that if students are aware of their own learning style, it can promote a fixed mindset whereby they believe they cannot improve an area outside their learning style based on restricted ability. This can greatly impact student motivation and success in several academic topics.

Moving Beyond the Myths

Given a further understanding of learning differences, learning disabilities, and learning styles, a shift in understanding is needed to develop optimal environments to foster creativity and problem solving.

Often creativity is reserved for gifted education classroom, when instead it should be incorporated in all academic environments and for all ability levels. A diagnosis of dyslexia, dyscalculia, or autism can bring unique challenges to educational environment. By focusing on limitations and fixed traits that are characteristic of learning differences an individual may inadvertently be discouraged from reaching his or her potential. The belief that creative ability is a fixed trait and cannot be increased, while popularly believed, has been repeatedly established as a myth. Instead it is consistently found that creativity can be taught in a variety of areas. Promoting a growth mindset may help avoid these academic myths thus enabling learners to develop their creativity in multiple areas. Encouraging a growth mindset, rather than fixed mindset, fosters creative ability and results in greater success.

Unfortunately, accommodating learning differences to design lesson plans that correspond to students' learning style is a popular paradigm. But research fails to support its validity.

To overcome pseudoscience, it is recommended that evidence-based approaches to instructional design that are appropriate to the content be employed. Educators should target their resources and time on combining multi-modalities of instruction to strengthen the student's comprehension of the content. Targeting the content of the material and encouraging a growth mindset, can help students become more effective in solving problems, making decisions, generating ideas, and becoming more creative.

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Logic and Reasoning

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Introducing the Link Between Creativity and Reasoning

Where do the best ideas come from? By what process or processes does an individual or team arrive at an elegant or original solution to a previously intractable problem? The potential answers to these questions, and the research paradigms that may be used to draw those possible conclusions, are clearly relevant to creative work and creativity research, because the production of ideas that are simultaneously original and meaningful lies at the heart of creativity (Runco and Jaeger, 2012). However, another and perhaps equally fruitful perspective on the investigation of these general research questions lies in the tradition of cognitive psychological research on reasoning. For example, the process of producing a highly creative idea may be described as a special case of reasoning or problem-solving, where the solution is both effective and also original. On the other hand, the reasoning process, when it is especially successful, may produce just such an effective and novel solution to a given problem. In this way, it seems clear that the individual mental functions, and probably also group discourse processes, that the creativity literature recognizes as relevant to the production of creative ideas may also be legitimately described as reasoning. How then, can one differentiate the two constructs and processes in order to inform further research, theoretical discussion, or even educational intervention? In this entry, evidence from throughout the psychological literature on creativity and cognition is marshalled to elucidate the similarities and differences between the creative process and the more logical process of reasoning.

Differentiating Reasoning Processes From Creative Processes

Traditionally within the creativity literature, the principal way in which reasoning or problem-solving processes are differentiated from more quintessentially creative thought is through the convergent and divergent thinking distinction. In this categorization, which is most often attributed to Guilford (1967), convergent thinking processes are those mental functions that allow an individual or group to *converge* upon an optimal solution to a given problem, regardless of whether or not that solution is original or novel. For example, an engineering team may effectively converge on an optimal solution to a mechanical design problem by drawing an analogy between the problem at hand and a previous problem they encountered, allowing them to effectively solve their problem without necessarily thinking originally.

In contrast, divergent thinking processes allow individuals or groups to produce a number of ideas that *diverge* in key ways from the initial problem or a culturally normative solution. For example, the same engineering team, when faced with a mechanical design issue, may choose to posit a number of divergent solutions to their problem, that are not structurally related to previous solutions they utilized. If one or more of these divergent solutions is feasible and effective, it would be a creative solution. However, there would certainly be no guarantee that the creative solution is more optimal, in terms of economic or engineering constraints, than the more prototypically convergent solution. In this section, a number of logical reasoning processes (deductive, inductive, and relational reasoning) as forms of convergent thinking will be described as well as four key components of divergent thinking (fluency, originality, flexibility, and elaboration).

Reasoning as Convergent Thinking

From the perspective of creativity research, reasoning processes can largely be characterized within the general category of convergent thinking, because they allow individuals or groups to target a correct or optimal solution to a problem. Such reasoning process are clearly relevant to creativity because the forwarding of a meaningful or effective solution (whether or not it is original) must require convergence in order to ensure that the solution is effective for the problem context.

Deductive reasoning. One classic form of reasoning, studied by philosophers for thousands of years, is deductive reasoning. Deductive reasoning is a highly formalized mental process that is based on premises about the environment that must be true in order for the deductive reasoning process to be effective. If the premises associated with the deduction are true, and the deductive reasoning process proceeds without errors, then the deductive conclusions must necessarily be true.

For example, one classic form of deductive reasoning—referred to as the syllogism—typically includes premises about the categorization of objects or people. Such as: *All reptiles are cold-blooded; All snakes are reptiles; Therefore, all snakes are cold-blooded.* In this example, if the two premises about reptiles and snakes are absolutely true, then the conclusion about snakes being cold-blooded must be absolutely true as well. For this reason, deductive reasoning has traditionally been privileged in Western philosophy as the most quintessential and most trustworthy form of reasoning. Some philosophers of science, most notably Popper (1959), have argued that all valid scientific reasoning should proceed deductively. This tradition in science is referred to as the hypothetico-deductive process and gave rise to the null hypothesis testing procedures still in use today, including within the field of creativity research.

Among creativity researchers, deductive reasoning is typically considered a highly convergent form of thinking (Weisberg, 2018), both because it is a constrained and formalized process, and also because deductive conclusions, assuming no reasoning mistake is made, must be true. In this way, deductive reasoning, when the context of problem-solving allows for it, is a highly effective method for converging on a truthful or meaningful conclusion. However, it is also likely that most real-world reasoning contexts do not necessarily afford very many opportunities for truly deductive thinking, because it is rare for reasoners to be certain of the veracity of their premises. If a reasoner's premises are less than certainly true, another form of reasoning, such as inductive or relational reasoning, will likely be more useful.

Inductive reasoning. In contrast to deductive reasoning, which begins with general premises that are assumed to be true, and proceeds to specific conclusions whose veracity is based on the truth of the premises, inductive reasoning begins with a number of specific observations about the environment and proceeds to the positing of a general premise that attempts to truthfully describe those observations. For example, if an elementary-school aged child has observed 50 swans in their life, and all of those swans have been white, that child might induct the general principle *all swans are white*. Of course, this general principle may or may not be absolutely true, but only reflects a probabilistic prediction on the child's part. In fact, a more formalized general principle drawn by this child may most appropriately be stated as, *based on my observations, all swans are probably white*.

It has been pointed out by scholars of scientific reasoning and philosophers of science that the creation of such general principles from specific observations more naturally describes the way science proceeds, in that scientists gather observations from empirical work, and attempt to form general theories that describe those observations (Dunbar and Klahr, 2012). Of course, the pervading role of deductive reasoning in science is also clear, in that the general premises formulated through empirical observations can and should be stated as hypotheses that could be disproven through further empirical observation. In this way, a movement between inductive and deductive reasoning processes allows science to move towards the discovery of principles that can be described as most likely to be true. From the perspective of creativity research, such a combined deductive and inductive reasoning process has the general goal of converging upon useful, optimized, and novel explanations for natural phenomenon.

Relational reasoning. Another reasoning process that allows for reasoners to converge on optimal or meaningful solutions to a given problem is relational reasoning, or the discernment of structural patterns among multiple pieces of information or mental representations of that information (Dumas et al., 2013). In this conceptualization, relational reasoning differs from the more basic form of pattern recognition and inductive reasoning in that it requires the identification of *higher-order relations*, or relations among relations among concepts.

For example, "protective covering" describes the first-order relation between the concepts *feathers* and *bird*, as well as the first-order relation between *fur* and *bear*. But the mapping of the higher-order analogical relation *feathers:bird::fur:bear* requires relational reasoning. Because such analogical reasoning is cognitively complex and requires a relatively high level of neurological development or working memory capacity, analogical reasoning problems have been historically utilized on intelligence or reasoning tests in education (Sternberg, 1977). But educators also capitalize on relational reasoning processes as a way to introduce new concepts to their students. For example, adolescents are often exposed to some aspects of cellular biology through analogies that map to domains in which they are already familiar. For instance, the mitochondria can be initially introduced to learners as being analogically related to a power-plant because it produces the energy that a living cell needs to function. In this way, a teacher draws on something their students already know (the power-plant) to introduce aspects of something they do not yet understand (the mitochondria).

In the analogical reasoning and creativity research literature, some scholars (e.g., Holyoak and Thagard, 1995) have pointed out that the mental leap required to map an analogy, especially if the concepts are relatively distant, bears some cognitive resemblance to the insight required for creative thinking. This initial observation has led to empirical work that has generally confirmed the hypothesis that relational reasoning plays a role in the creative thinking process, by allowing semantically distant, but structurally related ideas to be connected (e.g., Green et al., 2012). For this reason, the categories of convergent and divergent thinking are likely more porous in the case of relational reasoning than in the case of deductive or inductive reasoning. However, relational thinking certainly does not necessarily lead to original or novel ideas, instead, the mapping of structural relations may simply be a more elegant way of converging on an optimal solution or explanation in the reasoning context. In order to more definitively transcend convergent thinking and allow for creativity, thinking processes that are specifically divergent in nature must be employed.

Components of Divergent Thinking

Divergent thinking can be generally described as the mental process by which individuals or teams pose ideas that differ substantively from those previously posited, or that contain elements that are structurally different from the source-domain of the problem. One of the most famous divergent thinking tasks in the creativity literature is the Alternate Uses Task (AUT). In this task, participants are asked to generate as many novel uses for everyday objects as they can within a certain amount of time. For the given everyday object *book*, the response *read* would not be very divergent because reading is a typical use for a book, but the response, *throw like a frisbee* may be more divergent, because that use is not typical for a book. An individual's divergent thinking can be described along a number of dimensions that are generally concerned with both the quantity and novelty of the ideas produced. Here, four such dimensions will be briefly reviewed. Because these components of divergent thinking are described elsewhere in this encyclopedia, the description here is brief and in service of explicating the relations among creativity and reasoning (see Divergent Thinking).

Fluency. An individual or team's ideational fluency represents the quantity of ideas they produced during a divergent thinking session. In general within the creativity literature, a greater quantity of ideas is considered to be positive, because those individuals who produce very many ideas are also more likely to have produced more original, and even potentially more useful ideas (Dumas and Dunbar, 2014). In this way, a high quantity of ideas, produced via a highly fluent divergent thinking session is an important component of divergent thinking and creativity.

Originality. Clearly, producing a high quantity of ideas is not sufficient for being highly creative. In addition, the divergent thinking of an individual can be characterized by originality, which pertains to the novelty of the ideas produced. Although methods within the creativity literature for measuring the originality of a given idea or group of ideas differ, all center on the operationalization of the conceptual or semantic distance between the problem (e.g., the object-prompt in the AUT) and the proposed solution (e.g., a use of an object). In this way, originality can be conceived of as the divergent quality of a given idea, and perhaps the central requirement for divergent thinking and creativity.

Flexibility. In a situation where multiple ideas are produced in response to a prompt, the quality of the entire set of ideas can be described not only by the divergence between the prompt and the individual responses (i.e., originality) but also by the conceptual distance among each of the responses. Typically, an individual is considered a highly flexible thinker in the creativity literature if they are able to propose ideas that are drawn from a variety of different categories or domains but that all meaningfully pertain to the same prompt or problem-context. In contrast, even a highly original thinker may draw their original ideas from only one conceptual category, limiting the flexibility of their divergent thinking.

Elaboration. In addition to these three components of divergent thinking, individuals can also differ in the degree to which their ideas are rich in elaborative detail. For example, an individual who proposes ideas that consist of a number of specifically described elements may be more capable of creatively solving a problem than an individual who posits very vaguely described ideas. Such an elaborative quality may be specifically related to the prior knowledge that an individual brings to the divergent thinking context, but goes beyond that prior knowledge because it must essentially involve the detailed explication of ideas that are relatively original or novel to the domain in which the individual is working. In this way, elaboration influences the divergent quality of ideas posited during divergent thinking.

The Threshold Hypothesis and Creative Potential

Neither the convergent reasoning processes of deductive, inductive, and relational reasoning, nor the divergent thinking components of fluency, originality, flexibility, and elaboration are sufficient in themselves to constitute creativity. Instead, both convergent and divergent thinking processes are needed to produce ideas that are simultaneously novel and effective. For this reason, divergent thinking ability has been referred to as *creative potential* within the creativity research literature (e.g., Lubart et al., 2010), with the term implying that divergent thinking opens the door to creativity by allowing an individual to flexibly posit a number of original ideas, although only some of them (or none of them) might be effective, meaningful, or useful enough to constitute a truly creative solution.

On the other hand, a certain level of convergent thinking ability is also a necessary but not sufficient condition for creativity. For those in the creativity research field who focused their research on the convergent thinking associated with logic, reasoning, or intelligence (e.g., Karwowski et al., 2016), the *threshold hypothesis* states that such convergent thinking skills support creativity, but only up to a point on the distribution of convergent thinking. After an individual has the requisite amount of convergent reasoning ability, the likelihood that they will be capable of producing highly creative work is determined by their divergent thinking ability. The specific threshold at which convergent thinking abilities no longer support creativity is the focus of an ongoing debate in the literature, but it is most typically considered to be slightly higher than one standard deviation above average ability, or approximately 120 on the scale of traditional intelligence tests. In addition, some evidence exists that some fluid reasoning abilities, in particular relational reasoning, support divergent thinking processes themselves (e.g., originality), but also only up to a point (Dumas, 2018).

However, it should be noted here that, within the current literature on the threshold hypothesis, the evidence for or against the veracity of the hypothesis has been mixed depending on the particular creative outcome (e.g., creative achievement or divergent thinking) and the particular intellectual measure (e.g., fluid or crystallized intelligence) used in the research. For example, the threshold hypothesis has been more likely to be upheld in research studies that utilize more crystallized measurement tools

such as creative achievement checklists and measures of domain-specific prior knowledge (Sligh et al., 2005) than it has been in research using primarily measures that rely on fluid mental processes, such as divergent thinking tasks and visuo-spatial reasoning problems. Such a pattern may suggest the critical role that prior domain-specific knowledge plays in the creative process in that it allows for more effective convergent reasoning and logical problem-solving, which in turn supports creativity if it is combined with the creative potential of divergent thinking processes.

Interestingly, both the current conceptualization of divergent thinking as creative potential and the specific formulation of the threshold hypothesis among intellectual and creative abilities imply the same relation between logic and reasoning, on the one hand, and creativity on the other: a necessary but not sufficient relation. So, the evidence simultaneously suggests that both divergent thinking and logical reasoning are necessary for creative achievement, but neither is sufficient in and of itself. For this reason, it appears possible to more fully unify the psychological conceptualizations of logic and reasoning with that of creative thinking in that, as the introduction to this chapter implied, the process of producing a creative (i.e., both original and useful) idea could be conceptualized as a special case of the reasoning or problem-solving process in which the problem solution is original.

Future Directions for Investigating Creativity and Reasoning

Although there are thousands of published psychological investigations on the way in which reasoners employ deductive, inductive, and relational reasoning to converge on solutions to a problem, and there are also very many published studies on the process of divergent ideation, there is comparatively far fewer extant work that specifically examines the way individuals or teams utilize both logical reasoning process and divergent thinking processes to creatively solve a complex problem. Research on creative problem-solving may be less common because of certain methodological difficulties, for example the necessity to pose problems to participants that cannot be simply scored as right or wrong, but need to be evaluated more richly for levels of originality or effectiveness. In addition, formulating problem-tasks that are appropriate for creative problem-solving in that they simultaneously require a high level of convergent reasoning skills and prior knowledge, but also are open-ended and novel enough to inspire creativity, will likely be a challenge for researchers. For these reasons, an *in vivo*, or naturalistic observation approach, in which participants are engaged in real-world creative problem-solving while researchers observe, may be a fruitful research paradigm for investigating the interplay among logical reasoning and divergent thinking. Such an approach has been previously used to investigate convergent processes such as relational reasoning (Dumas et al., 2014) and may be extended to include a focus on creativity. In addition, much real-world creative problem-solving may unfold in group settings as teams work together to find an original and effective solution.

But, the way in which group discourse processes impact divergent thinking is not currently well understood in the creativity research field. The number of group members, the relationships among them, and a vast number of socio-emotional, linguistic, and contextual factors may play a role when groups are engaged in creative problem-solving, and therefore opportunities to examine the influence of these factors currently abound. Moreover, from an educational or perspective, how specifically can individuals or groups be taught to apply their convergent and divergent thinking skills more effectively in the creative problem-solving context? Therefore, the principal focus of this entry—the relations among logic, reasoning, and creativity—currently raises many more questions than answers. Indeed, it is not currently known, from a psychological mechanistic perspective, how original and effective (i.e., creative) ideas arise from a process of creative problem-solving. However, such a process certainly requires deductive, inductive, and relational reasoning as well as divergent thinking in varying amounts, in varying orders, and over varying lengths of time, depending on the problem-solving task and context. Such an open area for research should excite creativity researchers, because there is much to learn, and many ways to apply our own creative thinking as researchers, in the intersection of creativity and reasoning research.

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Longevity

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Creativity and Age

There is a widespread belief that creativity is associated primarily or exclusively with youth (e.g. see [Galenson, 2016](#)). This belief might seem odd when we think of some creative landmarks of the modern era. Darwin published *The Origin of Species* at the age of 50. Tolstoy published *Anna Karenina* at 49, Dostoevsky *The Brothers Karamazov* at 59, Twain *Adventures of Huckleberry Finn* at 50, Proust the final volume of *In Search of Times Lost* at 56, and Woolf *To the Lighthouse* at 45. Rodin completed the *Monument to Balzac* at 49. Robert Frost published “Stopping By Woods on a Snowy Evening” at 48, and Elizabeth Bishop “One Art” at 65. Frank Lloyd Wright completed the New York Guggenheim at 76, Le Corbusier Notre Dame du Haut at Ronchamp at 63, and Frank Gehry the Guggenheim Bilbao at 64. Alfred Hitchcock directed *Vertigo* at 59, and *Psycho* at 61; Clint Eastwood directed *Unforgiven* at 62, and *Million Dollar Baby* at 74. Irving Berlin wrote “God Bless America” at 51, and “White Christmas” at 54.

Perhaps these are mere anomalies, isolated examples of creativity at older ages? Quantitative evidence says otherwise. A recent study of nearly 3000 physicists found that a scientist’s most highly cited publication had an equal probability of being published at any point within the sequence of papers the scientist published ([Sinatra et al., 2016](#)).

Conceptual and Experimental Innovators

Creativity is not the prerogative of the young, but can occur at any stage in the life cycle. There is not a single kind of creativity, but in virtually every intellectual discipline there are two different types of creativity, each associated with a distinct pattern of discovery over the life cycle. The bold leaps of fearless and iconoclastic young *conceptual* innovators are one important form of creativity. Archetypal conceptual innovators include Einstein, Picasso, Eliot, Hemingway, Warhol, Godard, Plath, and Dylan. But there is another, very different type of creativity, in which important new discoveries emerge gradually and incrementally from the extended explorations of older *experimental* innovators. Darwin, Tolstoy, and the other late bloomers listed in the second paragraph of this article were all important innovators of this kind.

The differing life cycles of conceptual and experimental innovators reflect fundamental differences in both the nature of their creativity and the means by which they achieve it. Conceptual innovations express ideas or emotions. Conceptual innovators determine the purpose of a work before they begin executing it, so they typically plan their works carefully before executing them systematically. The clarity of their intent can allow them to feel that they have fully realized their objectives for a particular work. Conceptual innovations often appear suddenly, as a new idea can yield a novel work that fully expresses the idea.

In contrast, experimental innovators are concerned above all with perception. They work inductively to develop new methods based on extended observation and experimentation. They privilege process over products, and hope to make discoveries in the course of working. Their vague goals leave them feeling perennially dissatisfied with their work, but uncertain how to improve it. Their uncertainty leads them to proceed tentatively and incrementally, by trial and error. Experimental innovations consequently emerge gradually, over an extended period; they are rarely embodied in a single work, but appear piecemeal in a body of related works.

Conceptual innovations are surprising combinations of elements that had previously been unrelated. The most radical conceptual innovations combine elements that had previously existed in different domains, and the ability to connect these requires imagination and intellectual freedom. This is why radical conceptual innovation is typically the prerogative of recent entrants into a discipline, who have not had time to become constrained in their thinking by growing accustomed to following the domain’s established conventions and practices. Because most new entrants into intellectual disciplines are young, important conceptual innovations are usually made at early ages.

Experimental innovators want their products to emerge from sustained direct observation of reality. Their late innovations are generally their most powerful because they are based on greater accumulated knowledge, and formulated with greater technical mastery developed over long periods of study. The experimental innovations of cautious old masters often arrive gradually and unobtrusively, and may be long overlooked and undervalued (Galenson, 2018). Recognizing that important innovations need not be blatant, but can be subtle and inconspicuous, can help us correct the error of the longstanding scholarly belief that creativity is greatest in youth. It is consequently worth pointing out the specific mechanisms that connect age with experimental creativity. This can be done by considering the examples of some important experimental innovators.

Cézanne

The single year from with Paul Cézanne's work is most frequently illustrated in textbooks of art history is 1906 – the last year of his life, when he was 67. Two years earlier, in a letter to a younger friend, Cézanne (1995, pp. 299, 302, 315) assessed his own achievement:

In your letter you speak of my realization in art. I believe that I attain it more every day, although a bit laboriously. Because, if the strong feeling for nature – and certainly I have that vividly – is the necessary basis for all artistic conception on which rests the grandeur and beauty of all future work, the knowledge of the means of expressing our emotion is no less essential, and is only to be acquired through very long experience.

A few months later, Cézanne wrote to the painter Emile Bernard that “I progress very slowly, for nature reveals itself to me in very complex ways; and the progress needed is endless.” The next year, Cézanne again told Bernard that he believed he had made some progress, “rather slow,” in his latest works, then added, “It is, however, very painful to have to state that the improvement produced in the comprehension of nature from the point of view of the picture and the development of the means of expression is accompanied by old age and a weakening of the body.” These letters expressed Cézanne's conviction that above all two elements – the acuity of his perception of the subject, and the development of a technique that would allow him to express that perception – were critical to the improvement of his art, and his belief that both of these elements could only be the products of long and painstaking study. These letters also expressed his cautious judgement that he was making progress. Scholars have agreed, as Roger Fry (1984, p. 41) wrote of his “long research of an ultimate synthesis which unveils itself little by little from the contemplation of the things seen,” and Meyer Schapiro (1952, p. 27) declared that “the years from 1890 to his death in 1906 are a period of magnificent growth.”

Twain

Mark Twain emphasized that his fiction always grew out of things he knew directly – “life with which I am familiar” – so it is not surprising that he considered experience “an author's most valuable asset.” For Twain, experience was what brought fiction to life, and it could only be the product of deep knowledge of the subject: “Almost the whole capital of the novelist is the slow accumulation of unconscious observation.” This took time: “The life, the soul, the genius of a people are realized only through years of absorption.” In addition to the experience of life, the writer needed experience of his craft, which also required time: “Every man must *learn* his trade – not pick it up. God requires that he learn it by slow and painful processes. The apprentice hand in blacksmithing, in medicine, in literature, in everything, is a thing that can't be hidden.” (Dawidziak, 1996, pp. 15, 47–55). T.S. Eliot recalled that reading *Tom Sawyer* – “a boys' book, and a very good one” – had not prepared him for *Huck Finn*, “the only one of Mark Twain's various books which can be called a masterpiece.” He contended that Twain's growth in the eight years between the two books was not only in his skill in the use of language, but in his creation of the form of the narrative: “We look at Tom as the smiling adult does: Huck we do not look at – we see the world through his eyes. The two boys are not merely different types; they were brought into existence by different processes.” This created a basic difference in the depth of characterization: “Huck's persisting admiration for Tom only exhibits more clearly to our eyes the unique qualities of the former and the commonplaceness of the latter.” Twain's mature mastery of language allowed him to create Huck consistently and convincingly: “there is no exaggeration of grammar or spelling or speech, there is no sentence or phrase to destroy the illusion that these are Huck's own words.” Twain created Huck experimentally, for “*Huckleberry Finn* is not the kind of story in which the author knows, from the beginning, what is going to happen.” Twain's experience, both of writing and of life growing up on the Mississippi, allowed him to give a simple boy a quality that made him one of fiction's greatest characters: “Huck has not imagination, in the sense in which Tom has it: he has, instead, vision. He sees the real world; and he does not judge it – he allows it to judge itself” (Bloom, 2006, pp. 33–41).

Darwin

Charles Darwin's career was based on the conviction that theories should be the product of deep and detailed knowledge. At the age of 22, he accompanied a Cambridge geology professor on a trip to Wales. Darwin (2005, pp. 59, 132) was “utterly astonished” when the professor dismissed a single anomalous discovery as uninteresting, because of the lack of related evidence that the oddity was of

real significance. The lesson was lasting: “Nothing before had ever made me realize ... that science consists in grouping facts so that general laws or conclusions may be drawn from them.” At 62, Darwin gave a concise statement of his formula for creativity, in a letter congratulating his youngest son on passing a college exam. The boy was not a distinguished student, and Darwin’s own mediocre record as a student clearly allowed him to identify with Horace. His encouragement to his son stressed that creativity did not depend solely on intelligence:

I have been speculating last night what makes a man a discoverer of undiscovered things, and a most perplexing problem it is. Many men who are very clever – much cleverer than discoverers – never originate anything. As far as I can conjecture, the art consists in habitually searching for causes or meaning of everything that occurs. This implies sharp observation and requires as much knowledge as possible of the subject investigated.

Steve Jones (2011, pp. x–xi) recently emphasized the vast amount of evidence Darwin produced, and its far-reaching impact:

His lifelong labors – six million words in nineteen published works, hundreds of scientific papers, and fourteen thousand letters – generated an archipelago of information, a set of connected observations that together form a harmonious whole. Biology emerged from that gargantuan effort as a unitary subject, linked by the great idea of common ancestry, of evolution. The volumes written in Down House made sense of a whole new science and enabled its students to navigate what had been an uncharted labyrinth of shoals, reefs and remote islets of apparently unrelated facts.

Jones believed that Darwin “became a better scientist as he grew older for he began to test ideas with experiments, many far ahead of their time, rather than collating the results of others.” Antonello La Vergata observed that Darwin’s intellectual ability itself developed over time: “Darwin students today generally agree that Darwin’s theory was constructed, not discovered, and that it was the result of the evolution of a creative system: Darwin’s mind” (Kohn, 1985, p. 934).

Shakespeare

Harold Bloom (2002, p. 18) contended that the uniqueness of Shakespeare’s genius was in peopling a world with “men, women, and children preternaturally natural. Cervantes rivals him with two giant personalities, Don Quixote and Sancho Panza, but Shakespeare has hundreds.” Shakespeare was an experimental innovator; Stephen Greenblatt (2004, p. 299) observed that his achievement was “not a sudden, definitive innovation, but the subtle refinement of a particular set of representational techniques.” T.S. Eliot considered Shakespeare the greatest of poets and dramatists, and never stopped pondering the nature of his development, which served as a focal point for Eliot’s consideration of the relationship between age and creativity. Eliot marveled at the “slow, continuous development of mastery of his craft of verse,” that never ceased: “To the last Shakespeare is inexhaustible. Whatever he did was new” (Kermode, 1975, p. 250; Ricks, 1996, p. 392). Eliot contrasted Shakespeare’s creative life cycle with that of a transgressive young genius who was his exact contemporary:

We can also observe ... that the plays of Christopher Marlowe exhibit a greater maturity of mind and of style, than the plays which Shakespeare wrote at the same age: it is interesting to speculate whether, if Marlowe had lived as long as Shakespeare, his development would have continued at the same pace. I doubt it: for we observe some minds maturing earlier than others, and we observe that those which mature very early do not always develop very far.

Eliot thus recognized the difference between the life cycles of conceptual and experimental poets. Reflecting on the quality of maturity, Eliot remarked that Shakespeare’s greatness not only grew as the writer aged, but became more apparent to the reader as he himself aged: “No reader of Shakespeare ... can fail to recognize, increasingly as he himself grows up, the gradual ripening of Shakespeare’s mind” (Kermode, 1975, p. 117). In his last public lecture, at 73, Eliot (1965, p. 23) remarked that “So great is Shakespeare ... that a lifetime is hardly enough for growing up to appreciate him,” and in one of his last essays he declared that “of Shakespeare, the development of one’s opinions may be the measure of one’s development in wisdom.” The extended and gradual development of the experimental Shakespeare was alien to the conceptual Eliot, who considered it no less than miraculous that a poet “should find something new to say, and say it equally well, in middle age.” The conceptual Eliot’s own creative life cycle had followed a very different path, and the subject must have been an uncomfortable one in view of Eliot’s awareness of the loss of his own early creativity. But Eliot was too perceptive a reader not to recognize the growth of Shakespeare’s art over the course of his life, and too principled a critic not to ponder the ways in which his creativity grew with age.

Dickens

The greatness of Charles Dickens’ experimental art was a product of perception: the novelist Angus Wilson noted that “he had a marvelous ear; but, I believe, an only just less marvelous eye” (Ford and Lane, 1961, p. 379). Dickens’ genius lay in making readers see and hear his people. Thus T.S. Eliot compared his creation of characters to Shakespeare, “in that a single phrase, either by them or about them, may be enough to set them wholly before us” (Ford and Lane, 1961, p. 152). Wilson reflected that he was haunted “by

scenes and characters from Dickens' novels," but that this "obsessive power" of the novels "does not derive from their total statements; it seems to come impressionistically from atmosphere and scene which are always determinedly fragmentary" (Ford and Lane, 1961, pp. 375–76).

Dickens' greatest weakness was his plots. G.K. Chesterton facetiously contended that *The Pickwick Papers* was not a novel, for all novels must have an end, and *Pickwick* lacked one: "The point at which ... we find the printed matter terminates is not an end in any artistic sense of the word. Even as a boy I believed that there were some more pages that were torn out of my copy, and I am looking for them still" (Ford and Lane, 1961, p. 109). Dickens suffered from the experimental affliction that as his characters developed, they would not obey his plans for them: his eldest son reported that he had "often and often, heard him complain that he could not get the people of his imagination to do what he wanted, and that they would insist on working out their histories in *their* way and not *his*" (Collins, 1981, p. 120). And so Dickens' friend Edward Bulwer described Dickens "groping his way" through his manuscripts, working out the meanings of his novels as he wrote them (Douglas-Fairhurst, 2011, p. 199). Dickens' flexibility in plotting was such that he actually changed the ending of one of his greatest novels in response to a criticism by Bulwer. Thus Dickens wrote to John Forster that "You will be surprised to hear that I have changed the end of *Great Expectations* ... Bulwer so strongly urged it on me, after reading the proofs, and supported his view with such good reasons, that I resolved to make the change" (Forster, 1969, p. 289). Dickens published the revised ending in 1861, but ever since Forster revealed the original ending in 1874, generations of critics and scholars have debated the relative merits of the two versions. One of these scholars recently observed that revising the conclusion may have seemed "palatable" to Dickens because he had already significantly altered the first ending before Bulwer objected to it (Bloom, 2000, p. 177).

Among Dickens' great late achievements were *Great Expectations*, which he published at 49, and *Our Mutual Friend*, at 53. His art had developed in a number of ways over time. He improved his organization and plotting. Daniel Burt observed that "There is perhaps no better illustration of the remarkable development of Dickens as a novelist than by a comparison between the exuberant, picaresque improvisation of *The Pickwick Papers* [published at 25] and the taut control of *Great Expectations*" (Burt, 2004, p. 71). Dickens also refined his mastery of characterization. A key element of Dickens' success in creating vivid characters lay in his ability to give his fictional people individualized habits of speech, or idiolects. Robert Golding's linguistic analysis demonstrated that Dickens' use of this device grew more effective over the course of his career, as "the artistry revealed in their development and utilization makes decisively clear the author's gradual progress towards a bettering of his fictional art." Whereas in his early novels only a few characters had distinct personal idiolects, "in the works of the final period it was no longer ... a group of leading figures with very pronounced idiolects being supported by a cast of typified 'also-rans,' but one of a world in which each separate character is the possessor of a sharply delineated speech idiom which cannot be ignored." The richness of the later novels was a product of a gradual and progressive "stylistic transformation which took in Dickens' fictional writing as a whole, one which finally succeeded in merging all the elements involved – including the idiolects – into a finely balanced whole." (Golding, 1985, pp. 213, 219, 228).

Bishop

Late in his life David Kalstone (1989, pp. x–xi) set out to write a book about the generation of American poets who came of age after World War II, but as he worked, Elizabeth Bishop "eventually took over my book." The manuscript he left unfinished when he died was about "the steady growth of an extraordinary mind." The poet Thom Gunn (1993, pp. 78–79) recalled that when he first met Bishop, he felt that there was a depth in her personally that had not gotten into her poetry, but when he read *Geography III*, the last of her books published in her lifetime, "all at once everything was changed ... It was only ten poems long, and yet its achievement was such that it retrospectively altered the emphasis and shape of an entire career." Thomas Travisano (1988, pp. 154–205) pointed to specific ways in which Bishop's work developed over time. Her idiomatic language and conversational voice grew more relaxed. Her understated treatment of details of everyday life grew subtler. The timing of her poems increasingly allowed images to emerge gradually, as if the poem were being composed as the reader examined it. The tone of her writing became increasingly elegiac, so that even her most personal poems were not confessional in the standard sense: her meditations dealt with not only personal loss, but with the universality of loss. She treated humble and overlooked subjects, finding "[a]mongst the discarded and ignored ... examples of integrity, dignity, courage, humor, and grace." These qualities made Bishop's late poetry an inspiration to Gunn and other young poets who wanted to make their art from careful observation of life. Bishop had a profoundly experimental distrust of theorizing about poetry. But late in her life, in a letter to a literary scholar she came close to a generalization about why art might grow with the accumulation of knowledge and experience: "Well, it takes an infinite number of things coming together, forgotten, or almost forgotten, books, last night's dream, experiences past and present – to make a poem" (Bishop, 1994, p. 621).

Aging Gracelessly

In contrast to the examples of great experimental innovators considered above, old age has rarely been a time for major discoveries by conceptual innovators. A central problem is that the accumulation of experience in a discipline is the enemy of the radical departures from existing approaches that constitute conceptual creativity. The ability to perceive these typically diminishes in proportion to the time an artist or scholar spends considering a particular problem, because this time creates habits of thought that constrain the formulation of novel ideas.

It might be thought that conceptual young geniuses would be well advised to change their ways as they grow older, in order to change into experimental old masters. But historical evidence, which reveals very few cases in which innovators have made important contributions both conceptually and experimentally, suggests that this transformation is more easily said than done. Edouard Manet was one of these rare exceptions. Thus he made his famous *Olympia* by a conceptual process at the age of 31, then made his no less celebrated *Bar at the Folies-Bergère* 19 years later, by an experimental process that involved radical changes in the course of executing the painting (Galenson, 2006, pp. 51, 57). Manet's strong friendship with Claude Monet and the other members of the experimental Impressionist group may have been responsible for his evolution away from the careful preconception of his early masterpiece to the improvisation of his late one. But the rarity of his achievement points to the great difficulty of changing not only a way of working, but of thinking, from the clarity of a deductive conceptual approach to the uncertainty of an inductive experimental one.

A different path for aging conceptual innovators would be deliberately to make a novel conceptual departure in old age, completely different from their earlier contributions. The difficulty of doing this successfully is again suggested by how rarely this has occurred in the past. Two successful cases can be cited here, that coincidentally both took place at the age of 56. Thus Pablo Picasso, who had startled the art world with his *Demaiselles d'Avignon* at 26, produced *Guernica* 30 years later, and Gerhard Richter, who had pioneered European Pop art in his 30s, two decades later produced a series of 15 paintings from photographs of three deceased members of the Baader-Meinhof terrorist group. Picasso was outraged by the obliteration of a Basque town by German bombers acting for the Spanish fascists, just as Richter was by the deaths of the terrorists in a German prison (Galenson, 2009, pp. 139–40). The two artists' reactions to these shocking events was so strong that it jarred them out of their normal habits in the selection of subject matter, and this resulted in novel and important contributions.

Significant cases of conceptual creativity in old age are rare. Few aging conceptual innovators have had younger experimental colleagues as great as the Impressionists, and few conceptual artists have been able to make constructive responses to external events that shocked them. The loss of creativity was true even of as towering an innovator as Albert Einstein, who produced one of the greatest of all scientific breakthroughs at the age of 36, then spent the remainder of his life refusing to accept the next intellectual revolution created by younger physicists. Among the many scholars who have pondered Einstein's stubborn refusal to accept quantum mechanics, his friend and biographer Abraham Pais (2005, pp. 463–64) speculated that "making great discoveries can be accompanied by trauma, and ... the purity of Einstein's relativity theories had a blinding effect on him."

Creativity in Old Age

The belief that creativity diminishes with age is based on the misconception that the accumulation of knowledge and experience serves only to reduce the flexibility, and consequently the creativity, of the old. Greater knowledge, and associated entrenched habits of thought, do appear to constrain conceptual innovation, for they create barriers to the extreme simplifications that often characterize conceptual creativity, and they tend to erode the brash self-confidence of the cocksure young prodigy who can make bold leaps into the unknown because he is not yet aware of, and intimidated by, the complexity of his discipline.

But the recipe for experimental innovation is very different. Great experimental innovators develop not only vast stores of knowledge – "as much knowledge as possible of the subject investigated," in Darwin's words – but also the technical means by which to turn it into a novel contribution – Cézanne's "knowledge of the means of expressing." Both the accumulation of great knowledge and the construction of new technical means are "only to be acquired through very long experience," in Cézanne's words, and this implies that their greatest results will almost always appear late in a career. In the presence of appropriate technical expertise, greater knowledge affords the experimental innovator a larger and more trustworthy foundation for generalizations, to support ever broader and more far-reaching conclusions. A key contributing factor is that many great experimental innovators, like Cézanne, Darwin, Shakespeare, and Bishop, are "inexhaustible," never lose their fascination with their chosen discipline, and consequently never cease developing intellectually.

Old age and great experience may be lethal to the creativity of conceptual young geniuses, but they are the lifeblood of the innovations of experimental old masters. This analysis would come as no surprise to Paul Cézanne, Charles Darwin, Mark Twain, Elizabeth Bishop, or any other great experimental innovator. Among the latter was Louise Bourgeois (1998, pp. 318–19), a great experimental sculptor, who once declared, "I am a long-distance runner. It takes me years and years and years to produce what I do." Bourgeois made her greatest work after the age of 80. When she was 84, and an interviewer asked whether she could have made one of her recent works earlier in her career, she replied, "Absolutely not." When he asked why, she explained, "I was not sophisticated enough."

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Longitudinal Studies

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In order to understand better the creative development of children, adolescents and adults, it is necessary to compare their creativity at different ages. To do this, several methodological approaches are possible. Cross-sectional research compares age groups of different participants, observed only once at the same time, on the same measure, such as creative potential or creative achievement. In cross-sectional studies, there are as many samples as there are age groups, which makes it possible to coarsely trace development for a population. Based on these findings, researchers infer the development of creative potential on the basis of a data collected on different children. However, this approach does not make it possible to determine whether individual development is similar to mean developmental patterns observed at the group level. A second, potentially more powerful methodological approach is the use of longitudinal studies, which is the focus of this contribution. Longitudinal studies consist of following participants individually during the developmental period of interest through repeated examinations. Accordingly, comparisons by age are based on behaviors collected from the same participant. In this approach, intra-individual variability can be observed. Longitudinal studies make it possible to make the link between potential in childhood and achievements in adulthood. Researchers could also examine protective or risk factors for the development of creativity or evaluate the impact of a training program.

The exact longitudinal approach is not always the same, depending on the questions raised by researchers: some studies are short (few weeks), some are long (several years), some are prospective, others are retrospective (biographical studies). Thus, the duration and the number of intermediate examinations (present or not) depend on the researcher's objective.

In this contribution, we categorize longitudinal research. First, we will focus on retrospective, biographical studies. Second, we examine large-scale longitudinal studies from childhood to adulthood, which do not always focus exclusively on creativity. In the third part, we will examine the development of creative potential, in particular, with a focus on divergent thinking in many cases. In a fourth section, we will discuss studies that seek to identify factors that may impact creative potential. Finally, in the last part, we will focus on research related to education because creativity is considered today as a 21st century skills and teachers are invited to develop children's creative potential.

Bibliographic Studies

In retrospective studies, researchers are interested in variations in creativity over the careers of exceptional creators, whether during their childhood (Diezmann, 2008) or during adulthood for the majority of research (Caslistl, 2018; Simonton, 1984; 1997). There is also the question of tracing life paths and prerequisite characteristics that can explain the identification of creative works (Kohanyi, 2005).

Simonton (1984), following work by Lehman, investigated creativity in adults over their career, in terms of quantity and quality of their contributions. Regarding the quantity of creative productions, it is typical to count a creator's productions over a given period (e.g., 10 years). Generally speaking, the amount of creative production increases rapidly with age, reaching a peak around 40 years, and then productivity gradually decreases. However, differences are observed according to the creative domain. For example, Kozbelt (2008) observed a peak in the success rate of classical composers around 50 years of age, whereas the peak for mathematical researchers was around 30 (Simonton, 1984). Concerning the quality of productions, Simonton's results (1997) highlight a constant relationship throughout individuals' professional career between major works and creative activity. However, several authors (see Caslistl, 2018; Simonton, 1997) consider creativity to show content variation depending on the age of artists, with some studies suggesting a shift in topics and style, called "old-age style"¹ in some studies of artists and writers.

¹The "old age style" is characterized by (1) the importance of subjectivity rather than objectivity; (2) unity, harmony and integration of seemingly contradictory ideas; (3) the presence more important of aging theme.

Retrospectively, it is also possible to interview creators by focusing on the factors that have influenced their career. For example, Kohanyi (2005) conducted interviews with journalists and writers; both groups indicated that they felt different from other children (solitary, introversion) but distinguished themselves in terms of cognitive factors (aesthetic aspect of language for writers vs. socio-political sphere for journalists) and family environment (family centered on children for journalists vs. stressful families for writers).

Longitudinal Studies to Predict Adult Creativity

One objective of the longitudinal studies is to explore what factors can impact creative achievements in adults. In this research, the focus is often, at least, on two measures, one in childhood/adolescence or in young adults and the second in mid-life. Longitudinal research is important in a number of ways and sometimes researchers share their data in order to have an overall view on different aspects of development.

The Study of Mathematically Precocious Youth (SPMY) began in 1971 with the aim of better identifying the educational needs of young people with high potential. Teenagers were selected at ages 12–13 for their high verbal or/and mathematical abilities, measured by the SAT, used for entry to college. Ability at age 13 was related to patterns of creativity in adulthood, which vary in terms of the creative domain (science or human science) and the number of productions (see Park et al., 2007). In the same vein, Runco and Albert (2005) conducted a 20-year longitudinal study of high-potential teenager boys selected for either their IQ or their math and high-science abilities. Results highlighted relationships concerning wellness, sociability, and flexibility. Moreover, the creative performance of adolescents correlated strongly with the creative performance of their parents.

In Germany, Kandler et al. (2016) examined data from two partially overlapping longitudinal studies, including twins (GOSAT - German Observational Study of Adult Twins and BilSAT). During the third wave of evaluation on the BilSAT protocol, a graphic creativity test was administered whereas on previous waves, only questionnaires were used. The results highlight that perceived creativity correlated with personality dimensions of openness and extraversion. Graphic creativity correlated with the openness dimension of the personality as well as intelligence. The results show also that the primary source of creative performance variability was the environment.

In the United States, a 30-year longitudinal study was conducted, taking into account creativity in a female population (Mills Study of Creative Personality in Women). Women were seen at 21 and then at 52 years old. During these two measurement times, personality, motivation, cognitive and affective styles and creativity were evaluated; creative potential predicts creative achievements, and some dimensions of personality (creative temperament, originality, complexity, tolerance of ambiguity), professional aspirations (ambition, persistence) as well as cognitive and emotional styles predict creative achievements.

Feist and Barron (2003) conducted a follow-up study of eighty people, tested initially at 27 years old (assessing their intellectual skills, personality and creative potential) and then again at 72 years old (assessing their personality and creative professional success). The results show that creative potential and intellectual skills predict job success in terms of creative achievement. In addition, some personality variables (including tolerance of ambiguity) explain an additional 20% variance of job-related creative achievement.

Karwowski et al. (2017) conducted various studies in adolescents, young adults and middle-aged adults. In a first set of studies, they highlighted that the frequency of creative activities at 52 years is predicted by intellectual efficiency, evaluated 40 years ago. Furthermore, in research on the link between the creative potential of young adults and creative achievements in adulthood, they found that this correlation was mediatized by a sense of self-efficacy and moderated by the perceived value of creativity (Karwowski and Beghetto, 2018).

Although previous research has generally shown a correlation between creative potential in adolescents or young adults and later life adult's creative achievement, Clapham et al. (2005) did not find support; they examined the link between creative potential of engineering students and their creative activities in their profession 15 years later but found no link, which may be explained in particular by the fact that creativity seems to be specific to the field and that the divergent thought test used was not related to the area of professional expertise of the participants.

In addition, it is important to note that there are various factors that can impact longitudinal studies such as “experimental death”: indeed, even if, at the start of a study, the sample is representative of the parent population, it is not necessarily the same at the end, some years later, because various factors that lead to loss of participants (some lose contact, move away, etc) and therefore the nature of the sample may have changed.

Development of Creative Potential

The main objective of this type of research has been to observe qualitative and quantitative changes in creative development. Indeed, the question of the existence of a general developmental profile of creativity was raised, and studies suggested the presence of phases of stability and temporary decline in creative performance during development.

The first consequential study on the development of creative performance in children was conducted by E. Paul Torrance in the 1960s in Minnesota, USA. One objective of this research was to develop tests, notably the *Torrance Test of Creative Thinking* (TTCT). The second objective was to characterize the development of creative performance of children, adolescents and young adults from elementary school to university. Students completed the different tests of creativity for several years (since elementary school). Moreover, Torrance noted creative accomplishments that each participant had achieved so far. Torrance linked the performances

obtained in TTCT (verbal and graphic), with creative achievement in everyday life (Torrance, 1981). Plucker (1999) continued this research by finding more than half of the individuals ($n = 220$) and counting each participant's number of publicly recognized creative productions (articles, awards, inventions). Plucker's analysis showed that around 50% of the creativity of the adult individuals is explained by scores on the divergent thinking tests administered while in elementary school. Plucker found that this contribution of divergent thinking to the variability of proven levels of creativity was three times greater than that related to IQ.

Cramond et al. (2005) Runco et al. (2010) reported 40 and 50 year follow-ups of the original Torrance data. Cramond et al. (2005) tracked the original Torrance cohort 40 years later in 1998 with a response of 99 participants. In this analysis, 5 indices of creative achievement were taken into consideration with a questionnaire to measure the quantity and quality of creative achievements. The authors used structural equations with eight predictors (intelligence, initial TTCT scores (fluidity, flexibility, originality, elaboration), TTCT scores three years later, the questionnaire results in 1980 and those of 1998. The best predictors of the *quantity* of creative achievement were IQ, fluency, and originality on the TTCT. For *quality*, it was IQ, flexibility and originality on the TTCT, and the creativity index. The authors highlight gender differences: IQ was more predictive of the creative achievements of women than men. Runco, Millar, Acar, and Cramond (2010) followed up on the original Torrance cohort 50 years later in 2008 with a response of 60 participants. The goal was to test TTCT's predictive validity. In this research, a composite score was created for the 4 TTCT indices (Fluidity, Flexibility, Originality, Elaboration). This composite score correlated with personal creative achievements ($r = .35$, $p = .04$) and public creations ($r = .30$, $p = .012$). The authors found gender differences: men showed more public creative achievements and women personal creative achievements. Moreover, there was a quadratic relationship between TTCT indexes and personal creative achievements, intermediate levels of divergent thinking characterized people with the highest creative output.

Concerning the development of divergent thinking, Torrance's results suggested three periods of temporary decline or slump (first grade, fourth grade and seventh grade). Torrance provided a social explanation for the periods of temporary declines. However, as will be seen in the next part, many longitudinal studies highlight the role of different factors, cognitive, conative and environmental (in line with a multivariate approach).

Factors that Impact the Development of Creativity

Longitudinal studies can also help to better identify the joint evolution of creativity with other factors, as creativity is multi-determined. Numerous studies, whether in children, adolescents or adults, examine cognitive factors, in order to check the possible links between specific or general cognitive factors and creative performance or to see the joint evolution of different constructs. In this regard, several studies have sought to identify the reasons underlying the fourth-grade slump. Notably, Lin and Shih (2016) focused on the role played by fluid intelligence (measured by a reasoning task) and crystallized intelligence (measured by a vocabulary task) on two types of creativity tests, open problems (divergent thinking) and closed problems (traditional convergent thinking). Their findings show that only fluid intelligence has a link to creative performance, and in particular, children are more successful at closed problems when using type 2 reasoning (logic), whereas children are more successful at open problems when using type 1 reasoning (intuition). In the same vein, Fürst et al. (2012) have been particularly interested in the use of processes of generation and selection in art classes among young adults. Their results show that in the early session, the idea generation process is very important and then gradually decreases over the sessions whereas the idea selection process follows an inverted U curve highlighting the importance of this process in the middle-sessions.

Intelligence is a highly studied factor in terms of its connection with creativity. Welter et al. (2016) sought to test the threshold theory that there would be a correlation between creativity and intelligence up to an IQ of 120 and that thereafter there would be no link. To do this, their participants completed Raven's matrices as well as a graphical creativity test (TCT-DP), at the beginning and end of the school year. The results do not verify the threshold theory in this population and authors note variations influenced by the level of education of children and their gender.

In terms of conative factors, there is research on the link to moral development, as it is often necessary to think outside the box in order to propose new solutions. Niepel et al. (2015) who were interested in the link between ethical decision-making and creative performance of children aged 10 to 14 did not find a relationship between these two constructs, even when controlling for level of reasoning.

Some longitudinal research has also looked at the role of emotions. For example, to explain the decline in performance at seventh grade, Hee and Wong (2015) checked on the role of stress when children have to change grade level associated with a change of institution. Thus, they compared the level of stress and children's creative performance who were in this situation as well as children the year before and the year after. The results show that stress and therefore negative emotions are related to the slump in creative performance.

There is little consensus on the results of cross-sectional studies on the role of emotions. However, it seems that positive emotions play a major role in divergent thinking tasks. Rogaten and Moneta (2015) interviewed 130 students, in the first and second semesters, about their emotions over the past six months and their perception of their creativity. The results of this research highlight a positive relationship between positive emotions and creative cognition: the more positive emotions students experience and the more creative cognition they report.

Karwowski (2016) has been particularly interested in the evolution of two concepts, creative self-efficacy and creative personal identity, especially among teenagers and adults. An adolescent sample, aged 13 to 15 years, was seen at six months' intervals and the results show a stability of these two constructs. For participants aged 15 to 60 years who were seen 20 months apart, results show a change between the two measures, which can be explained by the life changes they tend to experience.

The environment is the last major factor that can impact creative performance. The family environment is the first to play a role. Harrington et al. (1987), in a longitudinal study, highlighted the importance of a supportive family environment for the development of creative performance, by maintaining constant gender, intellectual level and creative potential. They found a link between children's creative potential and their parents' creativity. Russ (2003) worked on the importance of pretend play in young children and highlighted that it predicts divergent thinking performance as well as fantasy of children's responses. Brook (1973) conducted a longitudinal family follow-up between children measured at 21 months and 18 years and then re-contacted "children" at 30 years with a questionnaire about artistic activities. She found that during childhood, gender differences were important in artistic activities and that this difference persisted in adulthood. Women who have had artistic activities during childhood described themselves as more unsociable, with a strong intellectual orientation whereas the men reported having a rich emotional life.

Among adults, the job environment has primary importance for creativity research. Longitudinal studies highlight the importance of social interactions and, more specifically, different forms of conflict or the pressure from the environment that reduce creative performance. Some studies show additionally the importance of taking a break to improve creative performance, as people who went on holiday improved their flexibility in a divergent thinking task.

Training Studies, Workshop Effects and Teachers' Mediation

Given the importance of creativity in the school environment, numerous research studies have sought to assess (1) the teachers' role and (2) the effect of workshops, pedagogical practices on the development of creative performance.

Transmission by Teachers

Teachers are primary mediators of thinking and learning for their students. Indeed, Fleming et al. (2016) have been interested in the link between teachers and their students, showing the importance of the presence of imagination and art teaching on students' academic motivation and their involvement as well as in their academic success. However, teachers, although they realize the importance of creativity, do not always know how to set up workshops or how to transmit this skill in connection with the academic skills usually taught. For example, Yates and Twigg (2017) propose a module for future teachers to encourage them in practical creative activities to develop their own creative skill and self-confidence. At the end of the module, students improve their knowledge on creativity and recognize, to develop children's creativity, the importance of proposing various activities and resources. In the same vein, Murray Or and Mitton Kukner (2015) propose a module called "literacy in the content areas" and highlight the more creativity-oriented teaching of these pre-service teachers. So Yates and Twigg (2017), like Murray Or and Mitton Kukner (2015), emphasize the importance of first practicing creativity to help teachers apply creativity in various activities with students. This education in creativity is very valuable as Karwowski et al. (2015) have shown that teachers' representations of their students' creative performance have an influence on creative self-efficacy as well as their sense of personal literary and mathematical effectiveness.

Effect of Pedagogy or Training Workshops

A first objective of this "mini" longitudinal research (a repeated measure study over a short-term period) is to examine the effect of pedagogical practices, whether permanent or more punctual. For example, research has shown the positive effect of alternative pedagogies on children's creative skills compared to traditional pedagogies (e.g. Besançon and Lubart, 2008). However, these results are not always favorable to alternative pedagogy, it may also depend on the type of task proposed or students' gender. More punctually, programs can be implemented over a shorter period of time. These programs are varied, such as the "Creativity Compass" program or the "learn to think" program which promotes scientific creativity. These programs are multi-month, even year-long, and the results show an improvement in creative skills (see the OECD study, Vincent-Lancrin et al. 2019), with these effects being found sometimes even a few years later (Hu et al., 2013). Some programs are short, taking place over a few weeks, showing a variety of effects (e.g., enhanced group work, reduced likelihood of leaving school earlier).

Research on students and young adults focused on the effect of different variables (such as creative self-efficacy, divergent thinking, creative intention, leadership, course satisfaction, group's norm) on creative performance in university teaching (e.g. Byrge and Tang, 2015). The results show that cognitive and emotional variables mediate the effects of contextual (e.g. course satisfaction, Choi, 2004a; 2004b) and individual (such as creative self-efficacy or creative intention, Byrge and Tang, 2015; Choi, 2004a, 2004b, 2012; Lim and Choi, 2009) variables on creative performance.

Other research has focused on the impact of various kinds of workshops on creative performance. This is the case, for example, with research, conducted by Gaggioli et al. (2015), in which teaching media psychology revealed an effect on collaboration, flow and creativity. Moreover, other research has focused on relaxation or meditation (Ding et al., 2015); results show an effect of meditation on creative performance of participants who practice meditation, which is not the case for those practicing relaxation.

Ma (2006) performed a meta-analysis of the effects of different types of training (e.g.: ideation, brainstorming, incubation, forced relation, catalog, improvisation, morphological synthesis, attitude, Syntectics, computer help, divergent-thinking-based programs). The results of this meta-analysis show a significant effect of training and it appears that training programs are more effective with young adult participants than with children and adolescents. The success of creativity training can be attributed to the development of cognitive skills such as strategies or thinking with a heuristic method.

In this kind of research, which deals with the effects of pedagogical practices, we observed that the use of a control group is not always present. Different control groups may be considered (1) an experimental group with the pedagogic practice that

the researchers wish to evaluate; (2) a group with the implementation of another teaching practice that should not have any effect on the development of creative performances and (3) a group where nothing is proposed. Thus, there should be significant differences in the development of creative performances between the creativity-focused treatment and each of these three groups.

Conclusion

Longitudinal studies provide important insights into the evolution of creative potential and creative achievements of participants. It is noteworthy that longitudinal studies take into account the different “dimensions” of creativity: from everyday creativity to eminent creativity. So far, most of the research has focused on either the development of creative potential in everyday life or the creative achievements of eminent people. An objective for future research will be to check whether the creative potential observed in everyday life at school or at home can determine creative achievements in professional life.

In recent years, researchers have developed new tools to assess creative potential (e.g. divergent thinking, convergent thinking, insight problems), creative personality or creative environment in which people evolve. One perspective of longitudinal studies is to verify that self-administered questionnaires predict participants’ creative achievements: does self-perception correspond to the potential that people express? The concurrent validity and predictive validity of creativity measurement tools remain to be demonstrated in longitudinal research. Second, creativity is multidetermined, so it seems essential to verify the impact of different factors on creative achievements of individuals. It should be noted that early research focused particularly on the creative person: concerning personality characteristics, studies have yet to demonstrate the effects of affects. Another point is to investigate each of the factors at different times in individuals’ lives. For example, does the environment in which the individual evolves have an equivalent influence at various developmental moments in a person’s career? The same question could be investigated for conative or emotional or cognitive characteristics.

Moreover, concerning methodological issues, recent advances in statistical analyses make it possible to have a more precise indication of the evolution of competences taking into consideration repeated measures and correlated errors. To date, longitudinal research have focused mainly on the study of inter-individual variability but work is needed on developmental profiles of creative potential that lead to accomplishments, taking into account the greatest number of explanatory factors (cognitive, conative and environmental). To go further, future research may focus on intra-individual variability over time looking, for example, about how emotions influence the creative process.

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Mad Genius Controversy

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The Mad Genius controversy has been the source of curiosity for centuries, creating a type of accessibility to eminent creativity typically thought of as a preserved icon. References throughout history have highlighted the belief that there can be no great genius without a touch of madness, as illustrated in the creative works of famous documented emotionally disturbed writers, poets, artists, philosophers, and scientists including Franz Kafka, Edward Munch, Ernest Hemingway, Sylvia Plath, Fyodor Dostoyevsky, Ezra Pound, Vincent Van Gogh as well as others widely cited in the literature. While literary accounts and oral histories present anecdotal connections between creativity and madness of creatively gifted individuals who were often plagued with emotional and intellectual challenges, what evidence exists to document a link between creativity and madness? What primary disciplinary approaches can be used to understand this link? And further, what does this association suggest for related research, and our understanding of creative people? The current entry aims to address these questions by presenting research approaches and examples to contribute to an increased understanding of the connection between creativity and madness. The entry begins with a brief history of the mad genius controversy, followed by research approaches and examples that have been used to study this link, an analysis of theoretical interpretations, and concludes with implications for the treatment of psychopathology.

A Brief History of the Mad Genius Controversy

A common belief held for centuries is that madness is linked with creative thinking. [Rothenberg \(1990\)](#) describes this thinking and corresponding behavior as, "Deviant behavior, whether in the form of eccentricity or worse, is not only associated with persons of genius or high-level creativity, but it is frequently expected of them (p.149)." Since the time of the Greek philosophers, writings about the creative process emphasized that creativity involves reverting to more primitive mental processes, that to be creative requires a willingness and ability to cross and recross the lines between rational and irrational thought.

This idea of a mad genius, while providing a level of insight into the origins of the exceptional talent, may also neutralize all envy of their abilities through the solace of not having their talent, but also not their problems. Perhaps the greatest consequence is when those who have been diagnosed with serious disorders and are truly in need of treatment, do not seek it for fear of diminishing their gifts ([Piirto, 2004](#); [Berlin, 2008](#)), or "dampening" [their] general intellect and limiting [their] emotional and perceptual range" ([Jamison, 2006a](#), p. 20).

Another perspective offered by historical accounts suggest that a touch of madness was the romanticized notion of what was required in order to be creative, causing playwrights, poets, and composers to identify with the stereotype of the mad genius, and display evidence of these symptoms as part of this persona. According to [Becker \(2011\)](#), the existentialist philosopher Jaspers believed that the greater manifestation of mental illness in geniuses was "the result of society's selective granting of fame (p.74)." In other words, for Jaspers, genius was a label applied socially to talented individuals who displayed signs of a kind of madness. Becker's interpretation of Jaspers' belief was that the concept of mad genius was not applicable to all historical periods; rather the distinguishing characteristic between the 19th and 20th centuries versus the 17th and eighteenth. Becker's interpretation further posited that it was the general mood or inclination in Western society that "craves the mysterious, the unusual, the undefinable, and the blatantly diseased (p.74)." The idea of these "unusual" representations of thought interpreted by many as creativity speaks to results of various studies and anecdotal reports suggesting an increased rate of schizophrenia, manic-depressive disorder, depression, personality

disorder or alcoholism among creative individuals. As Ludwig (1995) points out, it is also important to consider ways in which different types of emotional disturbances impact creativity expression. Depression, for instance, may decrease verbal associations, constrict coloration, encourage nihilism and sadness, shift focus from living to dying, and reduce work production. Mania may affect the rate, flow, and cadence of speech, increase prolixity and word play, produce disjointed and tangential thought, give rise to expansiveness and grandiosity, and foster prolific output or productivity. Schizophrenia may contribute to disorganization and incoherence in writing, musical composition, or painting, or provide the inflexibility of delusional convictions. Conservative amounts of alcohol and drugs may decrease inhibitions and performance anxiety, while increasing confidence, or offering new visions of reality; in excess, these substances may lead to muted, garbled, or nonsensical presentations of ideas and a decline in productivity and execution.

While it is quite clear that emotional instability is usually detrimental to creativity, it also may be advantageous. It may provide the intense focus, motivation, the conviction, egocentrism, the unconventionality, the imagination and the inspiration so necessary for new discoveries and breakthroughs. It may also allow the artist, writer, poet, composer and scientist to escape the powerful social and cultural constraints that mostly favor ease, conformity and convention.

Another lens through which to view this controversy is that of professional considerations which suggest that the creative arts attract certain types of individuals, and that expectations also determine whether or not they reveal any emotional difficulties. In addition, as Ludwig (1995) points out, individuals in the creative arts often flaunt their emotional instability as a badge of honor, receiving accolades, increased tolerance or understanding from others, while in other professions like the military or science, individuals hide their instability for fear of repercussions to careers and reputations.

Research Approaches to Studying the Link Between Creativity and Madness

Attributions of madness responsible for creative activity have often stemmed from such stories as Van Gogh's mutilation of his own ear and Truman Capote's alcoholism, fueling the popular belief that madness and creativity go hand in hand. However, researchers have also explored this controversy from three main perspectives, historiometric, psychometric, and psychiatric in an attempt to uncover patterns and determine trends.

The historiometric approach quantitatively analyzes historic data. Specifically, the biographies of eminent creators are systematically evaluated to identify the presence of symptoms associated with various psychopathological syndromes. For example, using this approach, Simonton (1994) examined 291 famous men in a study designed to determine the prevalence of various psychopathologies to test the hypothesis that the high incidence of mental abnormalities described in prominent living creative individuals would not be found in those who had achieved and maintained world status. Examinations of family background, physical and mental health, psychosexuality and personality of famous men in science, politics, thought, and art were investigated. The disciplines of these men included scientists and inventors, thinkers and scholars, statesmen and national leaders, painters and sculptors, composers, novelists and playwrights. Extracted data were coded according to DSM-III-R criteria where appropriate. Results of the investigation demonstrated that all these men excelled both due to their abilities and originality, as well as their drive, perseverance, and meticulousness. Their biographies revealed, with few exceptions, that they were all emotionally warm, sociable and friendly individuals. Simonton found that most of these men had unusual personality characteristics and that their minor "neurotic" abnormalities were more common than what was seen in the general population. Visual artists and writers in this sample had the most severe personality deviations, with functional psychoses restricted to the affective varieties, occurring less frequently than psychiatric epidemiology would anticipate. Results also indicated that among other functional psychiatric disorders, only depressive conditions and alcoholism were considerably prevalent in writers. In a more recent study, again using the historiometric approach, Simonton (2014) studied 204 eminent scientists, thinkers, writers, artists, and composers. Results revealed that scientists display the least psychopathology and the thinkers the most, with the composers falling approximately in the middle. As these studies illustrate, the historiometric approach yields the following three conclusions: First, among eminent creators, psychopathological symptoms appear to occur at a higher rate than in the general population (Simonton, 1994; Raskin, 1936). Depression appears to be the most common symptom often correlated with alcohol use and alcoholism (Ludwig, 1990; Post, 1996). Second, the more eminent the creator the more intense the psychopathology (Ludwig, 1998), and third, psychopathology is higher among artistic creators than those in the scientific domain (Post, 1994), indicating that the rate and intensity of symptoms varies according to the specific domain of creativity (Goertzel et al., 1978; Raskin, 1996; Post, 1994).

The psychometric approach applies standard assessment instruments (e.g., the Minnesota Multiphasic Personality Inventory (MMPI) and the Eysenck Personality Questionnaire (EPQ)) to contemporary creators (Gough, 1953). For example, Acar and Runco (2014) conducted a meta-analysis of 32 studies on the topic and found that when psychoticism was measured by the EPQ, the relationship between creativity and psychoticism was large ($r = 0.50$, 95% CI[0.39, 0.60]), indicating that the relationship between creativity and psychopathology appears to have an intermittent and specific relationship; rather than a broad and more general one. Acar and Runco (2014) go on to suggest that perhaps the fame and presence of psychoticism itself has an impact on what attracts fame and earns eminence. They further posit that a related possibility is that perhaps fame leads to a collection of detailed information in the form of biographies and autobiographies, which in turn allows easier interpretation of psychopathology. A key point they make is in the example of Isaac Newton, rumored to have autism. However, this rumor only started after autism was defined in the 1940s, during which time it was recognized as a legitimate diagnostic category for mental health professionals. After the definition of autism was made public, biographers could easily retrace Newton's idiosyncrasies, only because Newton was famous, and much had been written about him.

The psychiatric approach depends on clinical diagnoses and therapeutic treatments in contemporary creators. In the last two decades, a number of studies have examined the connections between creativity and madness from the psychiatric perspective, including works by [Rothenberg \(1990\)](#) and [Jamison \(1993\)](#). Observations from psychiatric studies identify three characteristics common to both high creative productivity and madness: disturbance of mood, certain types of thinking processes, and tolerance for irrationality.

In the genre of visual arts, disturbance of mood appears to be present in a high percentage of talented artists ([Jamison, 1989](#); [Richards, 1981](#)). According to [Neihart \(1998\)](#), mental disorders in which the primary feature is a mood disturbance include major depression, bipolar disorder (also known as manic-depressive illness), and dysthymia. In eminently creative people, especially writers and artists, there seems to be a greatly increased rate of depression and manic-depressive illness. The incidence of mental illness among creative artists is higher than in the general population. Some studies have linked creativity with bipolar disorders specifically ([Jamison, 1989](#); [Richards, 1989](#)), and within the field of academic psychiatry, there has recently been acceptance of the association between creativity and the mood disturbance, hypomania ([Jamison, 1993](#)).

The effect of moods on personality has been well-documented. Bipolar disorder is one example characterized as a recurrent mood disturbance typically manifesting as cyclical, extreme mood swings that include manic states. The manic state is a distinct period (around one week) during which an individual exhibits a euphoric high or irritable mood. The extreme poles are described by the [American Psychiatric Association \(1994\)](#) as, "The expansive quality of the mood is characterized by unceasing and indiscriminate enthusiasm for interpersonal, sexual, or occupational interactions (p. 328)." Grandiosity or inflated self-confidence is frequently observed. During a state of mania, thoughts race, often at a speed faster than can be articulated. There is an intensive increase in goal-directed activity, during which time manic individuals may paint numerous works, write volumes, or participate in multiple activities simultaneously. The intensity and level of activity may be so high that it results in functional impairment, with the possible need for hospitalization to protect the individual. Creative productivity is often preceded by elevated mood. [Jamison \(1993\)](#) suggests that certain moods appear to open up thought allowing for greater creativity, and that depression may have an important cognitive influence on the creative process by slowing the pace, putting thoughts and feelings into perspective and eliminating irrelevant ideas, heightening focus, and allowing the framework of new ideas to emerge. These observations suggest that perhaps the link between creativity and madness are the cognitive processes associated with certain moods.

One of the most interesting findings from the clinical literature are the documented similarities in the thought processes of psychotic, manic, and highly creative individuals ([Prentky, 1980](#); [Rothenberg, 1990](#); [Rothenberg and Burkhardt, 1984](#)). While it is rare for psychotic thinking to turn into creative production without some reduction of the psychosis, there is evidence that creative processes sometimes turn into psychotic ones ([Niehart, 1998](#)).

The comparisons of the three research methods reveal similarities of findings from the historiometric and psychiatric studies where symptoms found among eminently creative individuals are analyzed according to each field of study. The historiometric approach quantitatively analyzes historic data and focuses on symptoms found in biographies, which is the unique angle of this approach. Psychiatric studies also examine traits, diagnoses, and clinical perspectives of how creativity manifests in these individuals and at what cost or benefit to their mental health. The psychometric approach depends on clinical diagnoses also provided in psychiatric studies; but is unique in that it stresses the relationship between creativity and psychoticism as measured by standardized assessments. Each approach provides a unique perspective on what drives eminently creative individuals to produce at such high levels.

Theoretical Interpretations of Historiometric, Psychometric, and Psychiatric Research Approaches

What then is the actual relationship between creativity and madness? The interpretation of these research approaches and studies demonstrate that creativity shares common cognitive and dispositional traits with specific psychopathological symptoms, and that the way these commonalities manifest is dependent on the level and type of creativity displayed by the individual, which can be influenced by a number of factors including historical context and family dynamics. Specifically, evidence suggests that in order to be creative, novel, unconventional, and unexpected approaches combined with a willingness to explore such possibilities need to exist. Creators must be open to serendipity using such traits as divergent thinking, defocused attention, an openness and independence of thought, which together form a constellation of traits.

The greater the level of creativity displayed, the higher the likelihood that the individual manifests this constellation. In addition, some domains require this constellation more than others do. For instance, scientific creativity tends to be more reliant on logic and fact than artistic creativity. Thus, this creativity constellation of attributes will be more apparent in artists than in scientists ([Simonton, 2004](#)). However, differences will exist even within these general domains. For example, artists creating in a more classical, formal style will operate under more constraints than artists working in more expressive, romantic, or subjective styles ([Ludwig, 1998](#)).

Creativity can be said to be biologically determined to the extent that these symptoms have a genetic foundation. And though cognitive and dispositional traits are seen in psychopathological symptoms, many environments and circumstances provide conditions for the growth and development of these traits. For example, connections are often made between creative development and traumatic experiences in childhood or adolescence, experiences that may also contribute to depression and suicidal tendencies ([Goertzel and Goertzel, 1962](#)). While on the other hand, development of these traits are also linked to a rich, diverse, and stimulating intellectual and cultural environment, one that is neutral with respect to psychopathology ([Simonton, 1999](#)). Growing up in

the midst of such conditions nurtures the emergence of many cognitive and dispositional traits that define the creativity constellation of traits.

Implications for the Treatment of Psychopathology

The theoretical interpretations outlined previously indicate that creativity and psychopathology share a set of traits, and that the frequency and intensity of how these traits are expressed are dependent on the magnitude and domain of creative achievement. This explains why we see highly creative individuals manifest psychopathological traits. In addition, the disinhibition and overinclusiveness that may accompany some psychopathological states may give rise to unusual pairings of thoughts or ideas, which to the general public, may be considered highly unusual, novel, and creative, though they may not meet the definition of creativity as involving both novelty and usefulness. Though these symptoms may be at subclinical levels, they are also tempered by positive traits like ego strength, persistence, and forthrightness, which can be nurtured by environmental factors that lessen their tendency toward psychopathological states.

These concepts together suggest that creativity is not entirely inconsistent with mental and emotional health, supporting many cases of creative individuals who display little to no symptoms. For this reason, creative individuals should feel no hesitation to get the help they may need to assuage psychopathological symptoms as they appear for fear that their creative abilities will slip away. Treatment could, in part, focus on strengthening the positive traits like ego strength, and openness to experiences that have a positive relationship with creativity and mental health. Clinicians have taken an oath to be informed about the diseases they treat, and to recognize the importance of medication even if the individual rejects it. Some individuals can become addicted to mania—"as a drug, hypomania leaves cocaine in the dust (Jamison, 2005)"—romanticizing their illness and attempting to recapture their highs by any means possible. But the risks of refusing medication are higher than any creative loss that may occur, as seen in findings that demonstrate that patients on lithium are nine times less likely to commit suicide. In fact, even the loss of one's creativity should not be a great worry; two-thirds of patients report no change in intellectual ability and three-fourths no decline in productivity (Jamison, 1993).

Conclusion

The mad genius controversy is a polarizing and divisive issue in the field of creativity research but with the psychometric, psychiatric, and historiometric evidence reviewed here, it is likely that psychopathology and creativity are closely related; sharing many traits and antecedents while outright psychopathology may be negatively associated with creativity. Therefore, individuals with full-blown schizophrenia or alcohol dependence may not be demonstrating creative ability; rather only milder forms of these mental illnesses may be conducive to some forms of creativity. Family members of psychiatric patients may display higher levels of creativity, findings that are consistent in studies across all psychiatric disorders. While many creative individuals may feel stigmatized and ignore their psychopathological symptoms for fear of losing their creative ability, it is important to treat them to prevent adverse outcomes and overall reduction in their creativity during their lifespan. The poet, Kahlil Gibran (1918), beautifully captures his own connection with the mad genius controversy in these words, "I have found both freedom and safety in my madness; the freedom of loneliness and the safety from being understood, for those who understand us enslave something in us."

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Magic

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An Overview of the History of Magic

Magic, also called conjuring, aims at entertaining the audience with counterfactual illusions, such as making objects disappear or suspending them in the air. The person who performs the magic is referred to as a magician or conjuror. Historically, people's views toward magic have varied, which is reflected by the terms used to describe magic, such as illusions, tricks, black magic, supernatural power, and scientific spectacles. Accordingly, the magician's role has also changed throughout history and has included entertainer, showman, witch, trickster, and scientist.

The first historical record of magic is from 1700 BCE Egypt in the book known today as *Westcar Papyrus* (Blackstone and Reynolds, 1985). This book described a magician named Dedil, who performed magic for Cheops, the Pharaoh who built the pyramids. Other historical records also indicate that magic was performed in ancient Greece and Rome. For instance, Hero of Alexandria, the Greek engineer and physicist, who lived around CE 62, designed various mechanical devices for the temples. Those devices enabled him to perform magical divine phenomena to enhance the religious belief of worshipers. Some early magic records have also been found in Asian locations such as China and India. When Marco Polo (late 13th century) travelled to Asia, he described in his book *The Travels of Marco Polo* that Chinese conjurors could prevent rains and caused thunder and lightning (Blackstone, 1985). Polo reported that these Chinese performers performed solely for entertainment purpose at that time.

Although some audience members did regard magic performances as illusions and viewed conjurors as magic-entertainers or jugglers, some royal members of the audience may have interpreted the sleights of hand as displays of supernatural and occult powers. In early centuries, people even described magic performance as "black magic", and early Christianity regarded magic performances as pagan practices. Augustine (CE 354–430), in *City of God*, described magicians as men who used demonic arts. *The Discovery of Witchcraft*, written by Reginald Scot in 1584, aimed to dispel the myth of the supernatural power of magicians and exposed them as conjurors' tricks. Thus, magicians have played roles throughout history, including entertainer, trickster, and witch.

In the mid-eighteenth century, some magicians in Europe began to adopt the fruits of the industrial revolution—the latest scientific technology—in their performances. Thus, they played a new role as science demonstrators. For instance, Maillard demonstrated his artificial magical swan that could mimic the behavior of a natural swan in 1733. Starting in 1735, Jean-Antoine Nollet utilized electricity to produce his special effects, such as transmission of electric shocks to a group of people holding hands. These scientific magic shows occurred in small scientific fairs. When theaters began to appear in late 19th century America and England, magicians seized this opportunity and moved their shows from the street and scientific fairs to theaters. Nowadays, the main purpose of magic is still entertainment, but we also have witnessed several innovative uses of magic in fields such as education, therapy, neuroscience, and psychology.

The Innovative Use of Magic in Different Fields

Science Education. In recent years, magic has become a pedagogical tool for science educators to raise students' motivation in science education. There are two reasons for this: 1) the seemingly impossible magical effects always raise students' curiosity about the secrets of the magic; 2) some magic is based on scientific principles and knowledge. Therefore, some creative science educators use magic performance as a discrepant event stimulus to engage students in the scientific inquiry process with the goal of uncovering the science behind the magic. For example, *Brain Powered Science – Learning with Discrepant Events*, written by Thomas O'Brien (2010), is a science magic encyclopedia covering various types of science magic tricks and related pedagogical strategies to teach

chemistry and physics. In this book, he suggested that the unexpected outcomes demonstrated by magic challenged students' pre-conceived ideas and motivated them to examine their assumptions with empirical data and draw new scientific conclusions. His argument was also supported by the increasing number of empirical studies in science education research.

Therapeutic tools. Magic has also been used as a therapeutic tool to help students with disability or learning challenges. Since performing magic requires a high motor object manipulating skill, engaging students with motor disabilities in learning magic can improve their motor ability. The Project Magic program, established by the world famous magician David Copperfield, aims at teaching therapists how to use magic tricks as a form of therapy for improving patients' motor skills. A similar program, Hocus Focus, developed by Kevin Spencer, teaches individuals with disabilities magic tricks. Besides improving skills, both programs emphasize the positive influences of performing magic on individuals' self-esteem and communication skills. This is because magic enables individuals to create "miracles" that their non-disabled peers cannot achieve and thus gives performers a sense of achievement.

Neuroscience Psychologists testing tools. The magic props and mechanics developed by magicians is not the only reasons why magic is achieved. The main reason is that magicians know how to take advantage of the limitation of people's attention and perception. Magicians developed principles of misdirecting people's attention to hide the method and persuade the audience to believe in the reality of the magic effects. Those principles caught the attention of psychologists and neuro-scientists, who adopted magic tricks as an experimental tool to study visual attention, insight problem solving and memory distortions. To help psychologists use magic to conduct scientific study, [Rensink and Kuhn \(2015\)](#) developed a framework outlining how magic could be fully exploited to understand the human mind from four different levels: methods in magic, the effects of magic, the combination of effects and magic, and the experience of wonder.

While magic has been used in different fields for different purposes, the potential of magic has not been fully tapped. An increasing number of studies suggesting the connections between magic and creativity have begun to emerge. Before introducing how magic has been used as a tool for facilitating creativity, it is necessary to discuss these studies to understand why magic can be used to facilitate creativity.

Cognitive Dissonance

The effects brought about by magicians present a reality that differs from people's expectations. These effects create a magical experience that elicits a cognitive dissonance in the minds of audience members. The cognitive dissonance might disturb people's implicit beliefs about impossibility and possibility in the world, which might encourage them to think beyond the realistic world and thus enhance imagination. This special experience elicited by magic has been studied in the neuroscience, psychology, and social science fields, which establishes a foundation for using magic to facilitate creativity.

Recent neuroscience studies identified the brain areas influenced by the magic watching experience, which confirmed that magic performance is more effective in eliciting cognitive dissonance than other stimuli. For instance, [Parris et al. \(2009\)](#) used an MRI machine to investigate brain activity while watching a magic performance. Their results suggested that compared to other surprising stimuli, magic is more effective in activating the dorso-lateral prefrontal cortex (DLPFC) and the anterior cingulate cortex (ACC). The ACC is the area of the brain that mediates cognitive dissonance and controls the perception of causality. The ACC is activated when the brain is confronted with inconsistent information, such as impossible events. An example of this kind of event is a performance of the "suspended ball" trick. In this trick, a magician throws a ball into the air, where it remains suspended. When the ball is thrown into the air, the audience likely assumes that the ball will fall back down, according to their experiences. After seeing the ball suspended in the air, an alternative reality brought about by the magic disturbs the causal relationships learned through previous experience and knowledge, which activates the ACC. It is worth noting that ACC is related to people's cognitive flexibility, meaning that magic performance could be used as a stimulus to activate the ACC and further enhance creativity. However, no neuro-science study to date has directly tested such a connection.

On the other hand, research in social science studies indicated the connection between cognitive dissonance and divergent thinking, which indirectly provides evidence for the magic-creativity connection. For instance, [Ritter et al. \(2014\)](#) investigated the influence of cognitive dissonance on people's thinking flexibility. Specifically, they asked the participants to watch a film scenario that violates traditional thinking, and they found that those who watched the film scored higher on Guilford's Unusual Uses Task than those who did not.

This result was also supported by several cognitive studies. For instance, [Gołowska et al. \(2013\)](#) reported that individuals tended to generate more creative ideas when their mind were disturbed by counter-stereotypical social examples (such as a hippy-lawyer, a woman-rugby player). [Galinsky and Moskowitz \(2000\)](#) also showed that individuals who encountered a counter-factual mindset attenuated their confirmatory bias and generated more creative solutions to a problem. Although these social science studies did not use magic directly in their experiments, all of the stimuli used by them aimed at eliciting a cognitive dissonance in individuals' minds, and the results suggested a positive influence of cognitive dissonance on thinking flexibility. This implies that magic performance can facilitate creativity as magic is more effective at eliciting cognitive dissonance than other stimuli. However, these studies did not further investigate the underlying cognitive mechanism and explain why cognitive dissonance can lead to creativity. Therefore, to clarify this mechanism, the following section introduces magical thinking, an important concept that helps understand the underlying cognitive processes.

Magical Thinking

The term *magical thinking* varies by field. In psychology, magical thinking is generally used to describe people's belief that their thoughts, wishes or desires can influence the external world. Magical thinking has also been used in psychiatry to describe mental health disorders such as schizophrenia and obsessive compulsive disorder.

In this chapter, Subbotsky et al. (2010)'s definition of magical thinking is used to illustrate the connection between magic performance and creativity because of its emphasis on imagination. Subbotsky et al. (2010) defined magical thinking as the ability of individuals to construct an alternative world using their imaginations. In his book *Magic and the Mind* (2010), Subbotsky made a clear distinction between magical thinking and magical belief: magical thinking is related to imagination, whereas magic belief refers to an individual's belief that magical events may exist in reality and impact the real world. For instance, imagining Harry Potter or his magical power does not require believing either that Harry Potter exists or that his power could have a real impact in actuality. It is also worth noting that magical thinking differs from ordinary imagination in that it must involve violations of known physical principles. For instance, imagining flying with a broomstick like Harry Potter belongs to magical thinking, whereas imagining having a fancy car does not. In addition, children and adults differ in levels of magical thinking. As a child grows up, the magical view of this world is gradually replaced by realistic causal explanations. Compared to adults, children's fantasy and imagination are "stronger and richer because of the greater excitability of feeling, the intensiveness of experience, and uncritical judgement" (Vygotsky, 1991, p. 82). In other words, children's ideas are more original because they think less about reality and rely more on their own feelings and magical thinking.

The relationships among magical experience, magical thinking, and creativity have been investigated by a series of studies conducted by Eugene Subbotsky. One of his studies (2010) suggested that children who watched magical films (such as the *Harry Potter* series) significantly scored higher on originality on the Torrance Test than children who did not. He concluded that watching magical content encouraged participants to use their magical thinking and develop novel and counterfactual solutions to a problem.

A recent study conducted by Tong (2018a) further confirmed this. In this study, magic performance was used as a stimulus to facilitate thinking flexibility in an undergraduate class. Participants not only watched magic performance in class but also were taught to perform magic and learned the magic principles. The results suggested that participants' divergent thinking was significantly increased after the intervention. Furthermore, this study also clarified how magic influences people's magical thinking at different cognitive levels. The main influence is caused by the priming effect. Priming refers to a temporary activation of certain thinking that influences people's responses to tasks that follow. When participants had magical experience by either watching or performing magic tricks, they were primed with a magical thinking process. Once magical thinking was activated, participants were more likely to apply this thinking process to other activities and to come up with alternative ideas. Additionally, magic can also influence people's thinking at the reflective level. In Tong's study, participants not only watched magic performance but also learned how magical thinking benefits magicians and enabled them to develop creative magic ideas. Thus, they understood the value of magical thinking and became more willing to make changes and take actions toward the direction indicated by it.

The underlying mechanism revealed by studies mentioned above provides a theoretical support for the efforts made by practitioners in exploring the use of magic to facilitate creativity in design and science fields. These practitioners used magic and magical thinking to reduce cognitive fixation and inspire creativity in various ways, which will be introduced in the following sections.

Magic and Creativity in Design

In the design field, design fixation becomes a barrier for designers in finding and developing effective and creative solutions, especially during the ideation phase of design thinking. One method to reduce fixation is temporarily ignoring realistic constraints and imagining the possibilities and alternatives. Magic has been used to help designers escape those constraints and generate novel design ideas. For instance, Al'tshuller (1999) proposed a method for reducing designers' fixation by asking them to imagine that they were given a magic wand and they had the magic power to solve the design problem. The designers needed to think of idealized magical solutions so as to increase the uniqueness of their design idea. He suggested that using this method maximizes the imaginations of the designers and improves their design creativity. Similarly, Stanford professor John Arnold (2016) asked designers to imagine they were on a magical planet called Arktur IV to solve design problems. In both cases, magic was used to create a novel design space for designers. The magical design space elicited cognitive dissonances in designers and stimulate their magical thinking. The magical thinking mindset activated encourages designers to make unusual combination of different thoughts and ideas that cannot be achieved within a design environment full of rigid constraints.

In addition to using magic to create a magical design space, a few design researchers focused on the value of magic effects and the magic experience created by magicians to enhance the magical thinking of designers. For instance, Watson et al. (2014) proposed using stage magic effects (such as vanishing, levitation, etc.) to help designers develop creative products that can provide magical experiences to their users.

They translated the meaning of these magical effects into design elements that could be adopted by designers. For instance, the magic effect "levitation" means designing a product that can rise or hover by itself. Designers were encouraged to think of methods that enabled the products they designed suspend in the air. The study suggested that products embedded with such magical elements were more innovative and more preferred by the target users.

In another study, Busk et al. (2012) proposed a conceptual framework to inform product designers how to create a magical experience like a magician to improve user experience. The framework divides the magical experience into internal and external magical experience, depending on whether the user has control over the magic power. They suggested that designers should practice thinking about magic and consider how their design products could facilitate both types of magical experience so as to provide a pleasurable feeling for their users. In addition, there are design practitioners whose design practice directly benefits from magic performance and magical thinking. For instance, in England, designer Adrian Westaway adopted the principles he learned from magic in his design practice. He established Special Projects (<http://specialprojects.studio>), a design company that provides magical design solutions. In his TED talk, he shared the story of how being a magician inspires him to come up creative design ideas. His magic performing experiences encouraged him to consider improving the “magical feeling” of his design products.

Besides the use of magic effects and principles to improve magical thinking of designers and the uniqueness of their design products, the magic creating process of magicians also drew attention of design researchers. As suggested by a designer (Tognazzini, 1993), the development of a magic performance is similar to that of a user-centered digital product in that both try to create a virtual reality or magical experience based on the psychological understanding of human nature. Inspired by this, Tong (2018b) used the magic creating process of magicians to guide students’ product design process, in which students learned magic and the design principles from a magician and applied the principles to their design projects. The results showed that magic learning performance increased students’ empathy for their target audience and also enhanced their creativity. This study demonstrated a new approach to using magic to facilitate creativity—encouraging people to perform magic so that they can form a deeper understanding of the principles of magic. For instance, as a magician, in order to successfully trick the audience, it is necessary to think from the perspectives of the audience and refine the magic accordingly. Such magic performing experience might help people focus less on their own ideas and care more about the suggestions given by others, which might reduce their fixation and improve thinking flexibility.

Magic and Creativity in Science

As quantum physics emerges, the line between magic and science is becoming blurred. Some seemingly impossible magical effects become true in the quantum world. This requires scientists to not only rely on the traditional scientific reasoning but also on their magical thinking to envision the new possibilities. Österblom et al. (2015) used the fact that magicians trick their audiences as a metaphor to remind scientists not to be tricked by perceived experiences and realities. He suggested that scientists should think like magicians to challenge the perceived reality and explore this world with their imaginations. Previous research also suggested that such an imaginative mindset is crucial for scientist to make great scientific breakthroughs. For instance, studies of Nobel Prize and MacArthur Genius award winners indicated that their scientific contributions were connected to their early experiences with artistic practices (Root-Bernstein and Root-Bernstein, 2006). The imaginary experiences they received in the artistic activity enabled those award winners to conduct similar imaginary play in the scientific world.

Like magicians who try to break the realistic law with their imagination and are driven by unexpected magical events, those scientists who made scientific breakthroughs are aiming for expanding scientific knowledge with their imagination and searching for surprises and anomalies. For instance, Alexander Fleming, the British bacteriologist known for the discovery of penicillin, was also famous for his love of painting with germs. Although he was not an artist, his painting provided an imaginary space for him to play freely with living bacteria. To paint his pictures, he formed a familiarity with his “friend”— knowing which microbes produce which color and the timing of their growth rates. Most importantly, such special intimacy enabled Fleming to see through biological phenomenon and sense the unexpected patterns and outcomes. Fleming’s discovery of penicillin was a manifestation of his ability to envision new possibilities. If he had never imagined the possibility that mold could benefit human beings, we would not have penicillin to use today. Similarly, the virologist Jonas Salk, who discovered polio vaccine, said in his book *Anatomy of Reality*,

I would picture myself as a virus, or as a cancer cell, for example, and try to sense what it would be like to be either. I would also imagine myself as the immune system. I soon found myself in a dialogue with nature using viruses, immune systems ...

Magical thinking enabled Salk to not only establish relationships with the unfolding nature of mystery but also look at the problems in new perspectives. This increased his chances of discovering serendipity that lead to the next scientific breakthrough.

Interestingly, in the history of magic, many magicians were also great inventors. For instance, Hero of Alexandria, mentioned earlier, is believed to be the first person to invent a vending machine. Unlike the vending machines used today for simplifying people’s lives, Hero’s machine was built to demonstrate this automation miracle and enhance the magic belief of the temple followers. Georges Méliès (1861–1938), a French stage magician and film director, made the first fictional movies and invented the method of adding special effects to film. His magic performance experience and magical thinking inspired him to invent the tricks that changed movie history. Additionally, modern inventors also benefit from magic. For instance, Richard Garriott, an inventor, astronaut, and well known game designer who came up with the idea for the famous multiplayer online game *Ultima Online*, was inspired by his magic performing experience. In his book *Explore and Create*, he discussed how his early magic

performing experiences encouraged him to seek the real magic by becoming a game designer and adventurer. His experience inspired him to explore the unknown and believe that everything is possible.

Arthur C. Clarke, a well-known British science fiction writer, famously stated, “Any sufficiently advanced technology is indistinguishable from magic,” which suggests that technology inventors should think like magicians and believe that everything is possible. Magic thinking can encourage scientist or inventors to challenge traditional thinking and come up with ideas that can revolutionize the field. It is possible that performing magic can also encourage people to challenge traditional thinking and come up with great ideas.

Conclusion

Magicians devote their time and effort into creating wonder for audiences. This wonder- and magic-driven mindset might also benefit people in other fields in different ways. Watching magic performances may encourage people to expand their thinking and to change the existing world with their imaginations. The priming effect makes it possible to use magic to activate a counterfactual thinking mindset in people’s minds so as to enhance creativity. Additionally, through thousands of years of practice and development, magicians have developed their principles of creating magic that amazes their audiences. Those principles could be adopted by other fields that need to provide similar magical experiences, such as user experience design. It is worthwhile for educators to consider bringing magic into their classes and creating a magical environment for enhancing students’ creativity. And finally, thinking like a magician may encourage scientists and inventors to think beyond reality and explore the unknown world and thus bring about more scientific breakthroughs and inventions.

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Magic Synthesis

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Glossary

Bisociation One view of creative cognition, proposed by Arthur Koestler. It focused on a synthesis of unconscious and conscious thought and the combination of disparate bits of knowledge.

Magic synthesis The description of creative thinking proposed by S. Arieti. It is also known as tertiary process because it involves a synthesis of primary process material with secondary process.

Primary process Thinking and feeling that is unconscious, instinctual, raw, uncensored, uncivilized. It is guided by the pleasure principle.

Secondary process Thinking and feeling that is guided by the reality principle and involves censoring and governing primary process such that behavior is civilized, mature, and conventional.

Tertiary process A synthesis of primary and secondary process which leads to creative cognition.

The term, *magic synthesis*, was coined by Arieti in 1976 in a book of that title. The term is not used all that often, but as this entry will demonstrate, it is a very useful concept that is implicit in quite a bit of the thinking about creativity, even when the term “magic synthesis” is itself not used. In fact recent neuroscientific and cognitive research suggests that the concept is becoming an increasingly important one. That research will be summarized below, after Arieti’s own ideas are reviewed.

Arieti based his theory of creativity as a magic synthesis after a close examination of art. This is interesting because Freud said that “psychoanalysis can do nothing toward elucidating the nature of the artistic gift, nor can it explain the means by which the artist works—artistic technique Freud (1958, quoted by Gilman, 1976, p. 173).” Arieti also drew heavily from his work as a clinician. Often it is unwise to generalize from uncontrolled research, including that which involves examination of art, and even more unwise to generalize from clinical samples. On the other hand, such work does have value in its depth and in that it can suggest hypotheses which can be later tested with controlled research. This is exactly what happened with Arieti’s ideas about a magic synthesis. Several empirical studies, mostly by Klaus Hoppe, tested Arieti’s ideas, and largely supported them.

Freud’s influence on the concept of a magic synthesis is obvious in that it depends entirely on primary and secondary process. Indeed, the magic synthesis is the creative result of an interplay of primary and secondary processes. They are usually quite distinct and for the most part incompatible, but some of the time, for some people, they can be synthesized, the result being creative. Arieti’s description of that synthesis is a proposal for a mechanism to explain the origin of creativity. To the degree that the concept of a magic synthesis holds up to rigorous experimental research, this is enormously important. Too often theories of creativity are merely descriptive and fail to include an actual mechanism. Without a mechanism, there is no real scientific explanation (Jay and Perkins, 1997; Runco, 2007).

Primary process is raw, uncensored, libidinal, or what Arieti calls *paleological*. The id is readily apparent in primary process, and in fact newborns feel and express the drives supplied by the id. Their ego and superego have not yet developed and thus cannot direct libidinal and instinctual drives towards socially acceptable, realistic, or ethical expression. Secondary process censors primary process material so the individual can act in a mature and conventional fashion.

This idea of censorship is quite important for explanations of creativity. Think, for example, about Rothenberg’s (1990) interviews with the Nobel Laureate John Cheever. These interviews showed how Cheever drew from primary process—but it scared the hell out of him, to paraphrase. Such fear often arises when an individual realizes that their thinking or feelings reflect some primary process. It can be embarrassing or scary. This is why, according to Freud, people so often employ defense mechanisms. These can protect the individual so he or she does not realize that there is a raw libido and instinctual drive at work. Some defense mechanisms rationalize or project primary process drives. Art is sometimes thought of as sublimated primary process, the idea being that the raw unconscious provides ideas which are surprising and perhaps even original (because convention and morals keep most people from seeing and expressing them). Self-censorship of primary process is very important for a civilized society, but when taken too far, self-expression and creativity are likely to suffer.

This is all very important because, in addition to the key idea is that creativity is a magic synthesis of primary and secondary processes, Arieti also offered an equally noteworthy idea about the connection between health and psychopathology. Health and psychopathology are not two ends of a continuum, for Arieti, but instead sometimes related. Simplifying, the logic here is that there are people who experience psychosis or some psychopathology because they use a defense mechanism inappropriately (by society's standards) or there is a severe imbalance in the psychic system. You might say that the interplay of primary and secondary processes is suboptimal. There is also the possibility of an adaptive interplay of primary process and secondary process. It may lead to creativity! The point is that psychopathology and psychological health are connected, not entirely distinct from one another. The same underlying dynamic is at work in both. They are not opposites.

This same idea about health and psychopathology is explicit in the work of Hans Eysenck and his theory of overinclusive thinking. According to Eysenck, creative ideas result from thinking where the individual includes things that are typically excluded. A creative idea might make sense, but most people do not think of it because it is actually outside of the conceptual category as defined by convention. The idea of a "brick" is, for instance, outside of the category of "round things." Yet an overinclusive process often includes things that do not typically belong, so an overinclusive person may think of brick. Much the process has been described with the label *loose associative boundaries*.

One result of overinclusive thinking is that a person may appear to be out of touch with reality (bricks are not round!), and at the extreme, may appear to suffer from a form of psychopathology, perhaps even psychosis. Other individuals may think in an overinclusive fashion but control and direct it, or at least only share the ideas that result when they are in the service of creative thinking. Note that one result is psychopathology, but the other is a creative capacity. Both depend on one process, which is quite consistent with Arieti's theory. For Eysenck the mechanism underlying health and psychopathology is overinclusive thinking, while for Arieti the mechanism involves an interplay of primary and secondary process.

Evidence

As noted above, Arieti's ideas about a magic synthesis were based on observations of art and clinical interviews; but there have been empirical efforts to test the idea. The role of primary process has been included in a large number of theories of creativity (Kris, 1952; Koestler, 1964; Martindale, 1990), and some have been experimentally tested. Martindale, for example, examined the primary process underpinnings of creative products several times. The most direct test of Arieti's idea of a magic synthesis—where both primary and secondary processes are involved—was that of Klaus Hoppe and Neville Kyle, reported in the 1990 *Creativity Research Journal*.

Hoppe and Kyle worked with the patients of Roger Sperry, who won a Nobel Prize for his work on the so-called "split brain." The technical term of the operation is a commissurotomy because it was the corpus callosum (the bridge between the two hemispheres) that was cut in the patients. They were indeed patients, each of whom suffered from severe epilepsy. Each had frequent grand mal seizures, and for that reason did not lead fulfilling lives. This was before medication could control most seizures. The patients volunteered for the commissurotomy, the rationale being that after the surgery the two hemispheres of the brain would be much less likely to communicate with one another and therefore seizures would not be able to propagate from one hemisphere to the other. This would preclude grand mal seizures, which envelope both hemispheres. There might still be seizures but they would not be grand mal and not nearly as debilitating.

Sperry was not the surgeon; he was the psychologist allowed to observe the behavior of the patients after the surgery. He reported a few surprising changes and was able to infer that many linguistic processes and thinking that depends on traditional logic were controlled by the left hemisphere. When information was not available to the left hemisphere (e.g., only shown to patients via the left visual field, which feeds the right hemisphere), patients had extreme difficulty labeling things (i.e., finding the words) and difficulty with traditional logic. The right hemisphere, on the other hand, seemed to govern more spatial, simultaneous processes. This was sometimes misinterpreted such that people assigned creativity to the right hemisphere, as if it was always intuitive and processed information only simultaneously and all-at-once.

Sometime later Hoppe and Kyle (1990) worked with the same patients but focused on affect and creativity. Interviews and simple tasks indicated that the "split brain patients" had difficulty with fantasy and had difficulty finding words to express feelings. The latter was taken to be indicative of "a high degree of alexithymia," which is the label given to low levels of emotionality and affect. More details about the patients were given: "their dreams lacked condensation, displacement, and symbolization; their fantasies were unimaginative, utilitarian, and tied to reality; and their symbolizations were concrete, discursive, and rigid" (p. 151). One method employed by Hoppe and Kyle involved a film, without words but with a strong emotional message conveyed through visual symbols (e.g., an empty child's swing, moving to suggest that a child had been there but was gone) and music. The commissurotomy patients viewed the film four times, and after each a method was employed to explore their feelings and reactions. In addition, while watching the film EEGs monitored brain activity. Again quoting Hoppe and Kyle:

Commissurotomy patients symbolized in a discursive, logically articulate structure, using mainly a secondary process, as opposed to a presentational structure as an expression of a predominantly primary process. They also showed a concreteness of symbolization, emphasized low rather than creative capacity, lacked a summary of the whole gestalt, showed a relatively impoverished fantasy life, and tended not to be able to convey symbolic meanings. In other words, the quality of their symbolization emphasized stereotyped denotation as opposed to being flexible and rich in symbols, images, ideas, and connotations (pp. 151-152).

Note the references to primary and secondary process, which is what eventually led to the conclusion about creative individuals differing from the commissurotomy patients in that their hemispheres cooperated with one another, sometimes in a creative way and reflecting the magic synthesis, just as [Arieti \(1976\)](#) had proposed.

Hoppe and Kyle did additional research with various control groups and offered the following overarching conclusion: “The results indicate that creative and healthy subjects tend to have freer access to mutual interaction of both hemispheres without marked inhibitory or disinhibitory effects from either cerebral hemisphere” (p. 150).

Importantly, Hoppe and Kyle also proposed that there are individuals who have not had surgery to separate the hemispheres of the brain but who behave as if they have a functional commissurotomy. This meant that they do not utilize “tertiary processes” where primary and secondary processes work together, and in fact their thinking is much like the patients in Sperry’s research. These individuals are not very creative.

Hoppe and Kyle referred to a *transformational interocclusal process*, which is another way of describing communication of the two hemispheres, but it also points to the benefit of this process, namely a kind of transformation. That transformation is what leads to creative insight. They noted that this view of creativity is consistent with Arthur Koestler’s theory of *bisociation*, a process that ostensibly allows an individual to synthesize diverse kinds of information. Hoppe and Kyle extended this idea and referred to *hemispheric bisociation*. Quoting them one last time, they proposed that “the left hemisphere follows the fixed set of rules, [and] this code governs the matrix of an overwhelming possibility of choices expressed by the right hemisphere. The “magic synthesis” of the two cerebral planes is a creative process of hemispheric bisociation (p. 153).”

Conceptual Agreement About Creativity

The methodology and results of Hoppe and Kyle are quite interesting and directly relevant to [Arieti’s \(1976\)](#) ideas about the magic synthesis. They do not offer absolute confirmation about a tertiary process, but then again in one sense it would not be reasonable to look for such evidence. That is because the theory involves primary and secondary processes. As a matter of fact much the same can be said about several aspects of the creativity complex. Creativity is not entirely amenable to absolute rigor and control. This is one criticism of the product approach to creativity: it is highly objective but not really focused on a creative process, where creation actually occurs. Research on creative products focuses on things and information about the creative process that was used to construct the product must be inferred. But the creative process described in research like that of Arieti, or Koestler, or Hoppe and Kyle, is not manifest, so it too much be inferred.

Thus it is most reasonable to consider various methodologies and levels of analysis when studying creativity, especially because it is partly affective and may often involve subjective processes, including the unconscious. Studies of creativity must use optimal objectivity rather than the methods of the hard sciences. Recall here that [Hoppe and Kyle \(1990\)](#) used a variety of methods, including interviews, manipulations (i.e., the poignant films), and EEGs.

Although there is limited empirical support for the magic synthesis, there is quite a bit of conceptual support, especially concerning the synthesis aspect of the theory and not the role of primary process. Certainly there is evidence from various sources about the role of primary process in creativity, including [Martindale’s \(1990\)](#) investigations, several of which involved the *Regressive Imagery Dictionary*. In one compelling overview Martindale described “the clockwork muse,” where creative expression varies in a predictable fashion through history as society becomes more or less inhibited and behavior more or less a reflection of primary process. There is even more conceptual support for the creative process utilizing a synthesis. [Koestler’s \(1964\)](#) theory of bisociation, mentioned briefly above, is quite consistent with a magic synthesis, as are parts of [Kris \(1952\)](#) theory of regression in the service of the ego. Then there is the work of [Rothenberg \(1990\)](#) which included experimental demonstrations of how creative insights often utilize the integration of opposites (See Janusian, Homospatial and Sep-Com Articulation Processes).

The consensus among neuroscientists is that creative ideation is *combinatorial*. This is not always tertiary as Arieti described it, but it is close. In fact current neuroscientific research also acknowledges that creativity requires networks and systems and is not localized. This too is compatible with Arieti’s views. Most important is that there are quite a few reports of how syntheses, as well as combinations and integrations, can lead to creative ideation. Standing back, all of these point in the same direction, and the magic synthesis is close to the center of that general perspective.

Combinatorial and synthetic process views of creativity both differ from constructive views of creativity which describe the origin of ideas as constructions which do not depend on combinations or syntheses. Certainly both constructive and synthetic views may both hold up; there may very well be different pathways to creativity. [Piaget’s \(1976\)](#) theory of cognition exemplifies a constructive view, especially in his idea that “to understand is to invent.” The theory of personal creativity which is summarized elsewhere in this Encyclopedia also points to a constructive rather than synthetic explanation for creativity. It describes the construction of original and effective meaning as a creative act.

Conclusions

This throws a wide net, covering the Freudian view, shared with [Arieti \(1976\)](#) in his original conception of the magic synthesis, but also citing other applications and variations of primary process as an influence on creativity (e.g., [Martindale, 1992](#)). Neuroscientific work is cited as well, including that of [Hoppe and Kyle \(1990\)](#) and the EEGs of commissurotomy patients.

One more assumption from the magic synthesis can be considered. This is the assumption is that the creative process sometimes involves a kind of reconciliation of opposites. Recall here that primary and secondary process are very different from one another. The tertiary process is only possible if there is a tolerance and acceptance of opposites. That idea is also at the heart of Rothenberg's (1990) research, and in fact it can also be found in personality studies of creativity.

There are theories of personality that describe creative people as paradoxical. The paradoxical personality includes opposing traits which seem to be incompatible (e.g., masculine but also feminine, introverted as well as extroverted, moral but also immoral) but are somehow both apparent in the creative person. Both Donald MacKinnon and Mihaly Csikszentmihalyi reported data on such paradoxical creative personalities. This is relevant because it is consistent with the view that creativity involves flexible boundaries and regular syntheses. The paradoxical personality, like the magic synthesis, is only possible if there is tolerance and contradictions are accepted as compatible rather than mutually exclusive.

The idea of a magic synthesis goes back to at least 1976. Several of the ideas are alive and well in the current thinking about creativity. The evidence for the magic synthesis is sparse, and not all rigorous, but there is conceptual agreement when a broad net is thrown and parallels with bisociation, Janusian thinking, and other examples of synthetic thought are recognized. The broadest conclusion is that there seems to be a benefit to tolerating quite divergent perspectives on creativity.

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Management of Creative People

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To remain competitive in the increasingly changing world, organizations are placing greater value on creativity and innovation. While there are many different aspects that influence creativity and innovation in organizations, ranging from individual factors such as creative ability and expertise to contextual factors such as organizational climate and support for creativity. One important way in which organizations can facilitate creative performance of individuals and teams is through organizational leaders and their management of creative people and teams. Leaders work to create a productive internal environments or climates conducive to creativity. Internally, leaders also manage team composition, help teams take advantage of diversity, facilitate collaboration, and manage intra-team conflict. Leaders also facilitate creativity by managing resources allocated, ensuring continued organizational support, providing new information, diminishing negative organizational influences, facilitating communication within the organization, and promoting innovation initiatives.

Creative Individuals and Teams

Creative teams are composed of creative individuals, who often show a tendency towards independence and arrogance, which may increase tension in the team and team conflict. Leaders of teams are in the critical position of managing team interactions and social processes to facilitate greater team creativity and diminish tensions or other negative experiences that may inhibit creativity. Leaders should be aware that characteristics of the individuals who comprise a team influence team social processes and creative outcomes. Team diversity in relation to job functionality, educational background, and expertise, is crucial for creativity. While team diversity may facilitate creative performance, the strong personalities of creative individuals may lead to internal team conflict, which may inhibit the team's creative performance. Leaders should be aware that characteristics of the individuals who comprise a team influence team social processes and creative outcomes. Successfully guiding team interactions, and managing conflict are important tasks the leader must perform to aid creative problem-solving.

Fostering the Climate for Creativity

While creativity and innovation are viewed as desirable, and promote organizational growth and survival, creativity is often risky for organizations. Problems that require creative solutions are often complex and ambiguous. More importantly creative solutions are inherently risky because they have never been tried before, and therefore it is difficult to anticipate all the consequences resulting from implementing the solution. While ambiguous and novel situations allow space for creativity to flourish, the inherent ambiguity implies that creative efforts and ideas may fail. Consequentially, leaders in organizations may be hesitant to endorse creative ideas or products and may not be supportive of creativity by encouraging routine or well-established solutions. It is not surprising that research has shown individuals and teams develop more creative ideas when the environment is supportive of creativity and risk-taking (Hunter et al., 2005). When individuals believe their ideas and solutions are supported by leaders, they tend to feel less apprehension about sharing risky or unique ideas, thus increasing creativity.

Support for creativity and creative ideas is viewed as one important aspect of a climate that is conducive to creativity (Hunter et al., 2007). Leaders are important in creating and fostering organizational and team climate. Leaders can foster a climate that supports creative efforts in several ways. Specifically, research suggests that leaders facilitate such climate by promoting collaboration and information sharing, fostering psychological safety, and encouraging participation of team members. Promoting effective collaboration between team members is important for creative outcomes, as complex problems often require the contributions of multiple team members. Collaboration becomes particularly important to creativity when aspects of the task are subject to change, as team members must coordinate closely to ensure changes are shared within the team. Collaboration among team members requires that team members communicate effectively and openly with one another.

Such open communication concerning task-relevant information, referred to as knowledge sharing, is likewise associated with improved creativity. Leaders foster effective and open communication through creating a climate that supports information sharing and openness. Specifically, leaders are critical in creating an environment in which employees feel psychological safety.

Psychological safety refers to the extent to which employees feel secure and are willing to be true to self, without concern for negative consequences (Edmondson, 1999). Further, employees feel accepted and respected. Under these conditions, employees are more willing to share information and ideas, even when they are risky. Psychological safety is an important predictor for both individual and team creativity, as apprehension and reluctance to share ideas during brainstorming or idea generation will occur if employees feel their ideas will result in social rebuke or ostracization from the team or the leader. When employees feel psychologically safe, they perceive that ideas can be discussed openly and honestly, including discussing criticism and ideas for improvement. Leaders can facilitate psychologically safe environments by ensuring contributions are never met with negative consequences, empowering employees to participate during all discussion, and ensuring that no single individual dominates conversation (Carmeli et al., 2010).

Indeed, promoting active participation by employees has also been linked with facilitated creativity. Participation refers to individuals putting effort and thought towards group or organizational goal attainment and task completion. Participation is particularly important for team problem-solving as complex problems tend to require the knowledge, skills, and experience of each team member to effectively develop a solution. When team members interact during discussion or idea generation, team members are exposed to feedback on their ideas and potential alternative avenues to solve the problem. In turn, team members may build-up each other's ideas or combine ideas into novel solutions that more effectively solve the problem. When all team members participate and offer their unique perspectives, there is a greater chance that new ideas will arise from discussion thus facilitating the group's creativity.

Leaders can increase participation of team members by modelling open communication themselves (Boies et al., 2015). By setting the standard and expectation of an environment where individual members feel safe sharing ideas, team members may experience fewer negative emotions such as apprehension or anxiety that prevent engagement with the rest of the group. Leaders can use other strategies to encourage participation, such as preventing one single member from dominating the discussion. Alternatively, leaders can provide social rewards such as recognition or praise when more introverted team members engage with the team.

Managing Team Interactions

In recent years, more focus has been given to teams as the unit in which creative problem solving occurs. Teams are expected to be well-suited to creative problem-solving, as multiple individuals working together provides a greater pool of knowledge, wide-ranging skills, and various past experiences in problem-solving. However, with such diversity comes differing preferences, incongruent work styles, and other differences that may inhibit team performance and lead to conflict. Therefore, it is important for leaders to carefully consider the composition or make-up of their teams (Coursey et al., 2018). Discussions of team diversity typically differentiate between demographic diversity and functional diversity. Demographic diversity includes differences between team members such as gender, age, ethnic background, or race. Functional diversity refers to performance-related individual differences including job-relevant skills, knowledge, educational background, and unit of the organization.

A meta-analysis (Hulsheger et al., 2009) found no relationship between demographic diversity and creativity, while functional diversity in teams was associated with greater creative performance. Teams comprised of individuals who are different based on task relevant skills and knowledge are able to solve problems more creatively. This occurs because functionally diverse teams possess a larger pool of knowledge to draw from when anticipating and overcoming obstacles to success, and greater repertoire of past problem-solving experiences that may be relevant. However, evidence suggests that teams that are diverse, whether due to demographic diversity or functional diversity have difficulties in communicating effectively. Further, the dissimilarity between individuals may lead to misunderstandings and conflict, which are all detrimental to team performance in general and to team creativity. Managing team interactions to facilitate positive interactions and limit negative ones such as conflict are a critical aspect of managing creative people in creative teams. Leaders can facilitate positive interactions and effective communication by setting expectations, modeling appropriate behavior, and ensuring that negative behaviors be team members are not tolerated.

Team diversity is also important for team composition. Leaders can have a significant impact on the make-up of the team. When making decisions about team composition, leaders should select employees with relevant, yet varied, knowledge and skills to experience the benefits of functional diversity (Zhang, 2016). However, leaders must also work to ensure that each members' unique knowledge and skills are applied during teamwork. Fostering psychologically safe environments becomes important for functionally diverse teams to ensure team members feel secure in sharing their unique perspectives (Edmondson, 1999). Leaders can apply specific strategies in functionally diverse groups to develop their skill of being receptive to radical or novel ideas. One way in which leaders can facilitate more effective communication and reduce conflict is through facilitating shared understanding.

However, the relationship between conflict and creativity and team conflict is a complex one. Conflict can be expressed in two different ways (Jehn, 1995). Task-conflict refers to disagreements or tensions within the team concerning work-related approaches, strategies, or decisions. Relationship conflict refers to disagreements or tension within the team based on dislike and targeting a specific individual. Research suggests that relationship based conflict has a negative effect on team functioning and team creativity. Relationship conflict is particularly detrimental to feelings of psychological safety and to open communication, and therefore results in lower creativity.

The relationship between task conflict and creativity is less clear. In some cases, task conflict has been associated with greater team creativity presumably because teams that successfully navigate task conflict are able to discuss different ideas and perspectives, develop more nuanced understanding of the problem, and therefore increase creative performance. Other research suggests that task conflict may lead to less creativity, especially if there is a significant amount of task conflict. This may lead to the development of relationship-based conflict or create barriers such that teams are not able to navigate the conflict successfully. In fact, [De Drue \(2006\)](#) suggested that task conflict has an inverted-U relationship with creativity, such that too much or too little task conflict can be detrimental to creativity, while moderate levels of task conflict are most likely to be related to improved creativity.

Leaders of creative teams need to be aware of both the detrimental and facilitative effects of team conflict. Leaders therefore should create an environment in which moderate levels of task conflict can be possible, but too much task conflict or relationship conflict are discouraged. Not surprisingly, creating an environment of psychological safety can facilitate effective task conflict. When team members are able to communicate openly and honestly about disagreements regarding the task, but do so in a constructive and focused manner, task conflict can occur, but relationship conflict is limited. Leaders can further model how constructive and effective feedback, including negative feedback is provided and received, and should not allow for personal criticism and disrespectful discourse.

Managing Relationship With the Broader Organization

Leaders do not operate in a vacuum. As a result, leaders must take into account the goals of their immediate workgroup and the broader organizational goals. Leaders must also attend to restrictions posed by the organization, such as resources, time, as well as political issues within and outside the organization. In addition, leaders serve as the connection between their team to the larger organization and to the environment external to the organization including customers, suppliers, and competitors.

Resources are an important organizational issue that may facilitate or inhibit creativity and innovation ([Petrou et al., 2019](#)). Organizational leaders are critical in obtaining resources, and allocating these resources within the team. A number of studies have found that slack resources, or the availability of resources, were linked to creativity and innovation ([Greve, 2003](#)). The availability of resources allows for creativity due to the ability to allocate time and energy towards experimentation and innovation ([Amabile et al., 1996](#)). However, other researchers argue that limited resources can foster creativity. Organizations with limited resources tend to be newer organizations and allow for flexibility, which in turn facilitates creativity. Limited resources are also viewed as a challenge or crisis, which may require creativity ([Scott and Bruce, 1994](#)).

Similar to conflict, [Mumford and Hunter \(2005\)](#) proposed that a curvilinear relationship may exist between resources and creativity. While some amount of resources are necessary for creativity, having too many resources may facilitate less selective choosing of projects and investment in more risky and likely to fail ideas. That is, too little will lead to failure of creative projects, as the team does not have the time, funds, knowledge, or personnel to engage in the project successfully. Too many resources can lead to having too many projects, not eliminating projects that are likely to fail, and investing in projects that will result in less successful and less creative ideas. Leaders can be important in knowing what organizational resources are available, and how to then transform and use these resources for maximum capacity. Leaders therefore can manage creative people and creative ideas by managing the resources available to the team.

Leaders also serve the role of communicating the ideas developed by the team within the organization, further providing support for the team and its projects, including (but not limited to) resources ([Howell and Boies, 2004](#)). Leaders are viewed as boundary spanners, that is, those individuals that serve as the boundary between the team and the larger organizations or entities outside the organization. As such, they protect the team from potential negative interactions and consequences and focus on championing the team and its projects to the organizational decision makers. Leaders therefore are also viewed as potential champions for innovation. That is, leaders serve an important role of promoting the work of the team and its projects to those in the organization that can provide further support and resources for the team.

Leaders should also develop relationships with those outside of the organization. For example, in meeting consumer demands, it is critical to understand the targeted consumer and current market which can be accomplished by establishing working relationships with those who have the necessary information. Communication with competitors, suppliers, consumers, and collaborators allows a greater understanding of how the team and organization operate within the wider environment ([Scott and Bruce, 1994](#)). Research suggests that open communication and availability of market information are critical for effective idea generation. Thus, leaders can then provide teams with valuable information that was not easily accessible and more effectively facilitate new product idea generation.

Managing the Work

One way in which leaders can promote creativity and manage creative people and teams is through facilitation of creative problem solving. Leaders may facilitate creative efforts through the facilitation of effective implementation of creative problem solving processes in the team by facilitating idea generation. Research indicates that the use of facilitators or leaders who stressed brainstorming rules also increased idea generation. Further, leaders or facilitators who focused on specific rules for ideation and discussion of the ideas such as suspension of judgment, allowing everyone to speak or participate, and ensuring psychological safety

during brainstorming or ideation are critical for effective ideation were more successful. However, other research suggests that brainstorming techniques are not effective in eliciting creativity, and are no better than nominal groups (that is, individual output which is then pooled together).

While the generation of multiple ideas is important, and is thought to increase the creativity of the ideas, ideation is not the only cognitive process that matters for team creative problem solving. Processes that occur before idea generation such as problem identification and construction and information search and sharing, as well as those that occur after generation, such as idea evaluation and selection are all important for teams seeking creative solutions (Reiter-Palmon et al., 2008). Leaders can facilitate the discussion of different perspectives regarding the way the problem is conceptualized, ensuring that different views are presented, listened to, and integrated, which will result in better conceptualizations of the problem, and more creative solutions.

While the research on idea evaluation is limited, it suggests that leaders can facilitate idea evaluation and idea selection by supporting discussion of these ideas, ensuring that ideas are evaluated, and creating a shared understanding of the standards used for idea evaluation. Further, leaders need to be aware of the cognitive resources required for effective idea evaluation and provide teams with sufficient time to engage in this activity. Leaders can further aid in the idea evaluation and selection process by clearly identifying the standards used for idea evaluation, standards that typically emerge during problem construction (Reiter-Palmon et al., 2008). A clear understanding of the standards will facilitate idea evaluation creating a shared understanding and a shared framework as to how ideas should be evaluated, resulting in a more efficient and effective process.

Conclusion

While many organizations are increasingly relying on creative individuals and teams to remain economically relevant, creative employees may not receive the resources and support required to apply creative thought. Leaders and supervisors are then responsible for creating the proper culture and expectations that supports creativity. Specifically, leaders can foster psychologically safe environments where employees feel safe sharing ideas and providing their perspectives and opinions at work. Similarly, leaders that promote collaboration between employees and encourage knowledge sharing may increase employee creativity. During teamwork, leaders play an important role in managing team interactions to facilitate innovation. Leaders can make decisions concerning team membership and composition to ensure individuals from various work domains are represented in the team, thus taking advantage of the inherent diversity teams entail. When conflict arises, leaders can take steps to reduce negative impacts on creativity and can take action to facilitate employees' engagement with creative processes.

Leaders also serve as the link between the team and the broader organization. Creative thought is often time and resource intensive, and planning for complex situations may result in an underestimation of the resources necessary. Leaders can serve as champions for innovation to the organization by promoting innovation initiatives, ensuring teams are provided with the resources necessary to produce creative solutions, and maintaining organizational support for the team's continued tenure. Finally, leaders serve as an intermediary between the team and other external influences, increasing the amount of information or resources available both within and outside of the organization. Leader contacts outside the organization can provide the teams with greater understandings of the economic environment, such as competitors and trends.

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Mathematics

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A clear, concise definition of mathematical creativity is elusive. Categorizing the product of mathematical work, the solution to a problem, as creative is but one aspect of creative mathematics; a narrow and utilitarian view. Mathematics is more than solutions to problems: it is a way of thinking; it is both exploring patterns and relationships in the real world and investigating theoretical abstractions that are intriguing and may have unexpected practical applications. It is both an applied science that provides the tools and language that apply universally across other aspects of human thought from agriculture to physics, from music to politics, and a means of creative expression that allows us to define a set of conditions and explore the outcomes. The later, often referred to as pure (as opposed to applied) mathematics is part art, part science. Browder (1976) defined pure mathematics to be “that part of mathematical activity that is done without explicit or immediate consideration of direct application to other intellectual domains or domains of human practice” (p. 542) and shares several examples of how work in the field of pure mathematics often leads to applications in the sciences. Work in the field of pure mathematics requires creativity or to use Browder’s words, “innovative originality of a very high order” (p. 543).

The Relationship Between Creativity and Mathematics

In school mathematics we encountered many exercises designed to build a mathematical knowledge and set of skills that will equip us with the tools we need to solve problems. Often obscured in these experiences is the creative nature of mathematics as time is spent being shown how to solve exercises with known answers carefully selected for educational objectives rather than providing opportunities to engage in creative mathematical thought; to ask our own questions, and seek solutions to problems we construct. These types of experiences contribute to a common misconception that creativity and mathematics are unrelated. In the preface to his text on mathematical discovery George Polya (1962) describes the mathematical problems he shares with his students as case histories of solutions or a description of the “...sequence of essential steps by which the solution has been eventually discovered...” (p. viii). Polya’s effort was designed to help “...make room for *creative work on an appropriate level*” [emphasis in original text] (p. x) in the training of future high school mathematics teachers. While there is a body of knowledge to be learned, the essence of mathematics is applying and extending that body of knowledge by exploring new and interesting problems.

Creativity is an essential aspect of problem solving. E. Paul Torrance, often referred to as the “Father of Creativity,” defined creativity as

a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies: testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results. (1966, p. 6)

Problems in this context are not Polya’s case studies; those exercises found in school textbooks or mathematical competitions hopefully thoughtfully chosen to lead students to discover for themselves known successful solution methods and mathematical properties and relationships. Runco (2007) in his writings on personal creativity separates problem-solving from proactive creativity

...distinguishes creativity from problem solving because problem solving is always a kind of reaction. First there is a problem, then with a bit of luck and skill, there is a solution. Proactive creativity sometimes allows the individual to identify, anticipate, or define a problem, although these actions are different from solving a problem (Runco, p. 98)

In the 1938 text, *Evolution of Physics*, Einstein and Infeld write,

The formulation of a problem is often more essential than its solution, which may be merely a matter of mathematical or experimental skill. To raise new questions, new possibilities, to regard old problems from a new angle requires creative imagination. (p. 92)

Both Torrance and Runco define problems as thoughts, questions, curiosity, or challenges that are identified by the individual rather than given. To do so necessitates a sensitivity to the problem, an assessment of what is and is not known, and a search for solutions starting with an informed guess then testing and possibly modifying that guess until a possible solution is found and communicated to others. This creative process is in play in a classroom when a child is given the opportunity to explore negative numbers (consider controversial into the 1800s) or the properties of arithmetic as much as it is for the theoretical mathematician who is exploring motion and relationships in higher-dimensional space.

Indicators of Mathematical Creativity

Studies of mathematical creativity have defined it a variety of ways. Wallas (1926) discussed the characteristics of mathematical creativity viewing the concept through a Gestalt model of preparation, incubation, illumination, and verification. Others have described creativity in mathematics as an ability to discern relationships between techniques and areas of application and to make associations between possibly unrelated ideas. Mandelbrot's autobiographical article on the fractal universe is an excellent example of this ability. The Russian psychologist Krutetskii (1976) considered mathematical creativity as a multi-dimensional construct involving problem formation, invention, independence, and originality. Others have applied Torrance's framework of fluency, flexibility, and originality in assessing creativity in mathematics adding elaboration (extending or improving methods) and/or sensitivity (constructive criticism of standard methods).

Balka (1974) introduced a comprehensive set of criteria for measuring mathematical creative ability based on the works of Guilford; Harris and Simberg; Torrance; and Meeker. He addressed both convergent thinking, characterized by determining patterns and breaking from established mindsets, and divergent thought defined as formulating mathematical hypotheses, evaluating unusual mathematical ideas, sensing what is missing from a problem, and splitting general problems into specific sub-problems. Like Balka, Haylock (1997), and Krutetskii (1976) argued that overcoming mental fixations (or the Einstellung Effect) was necessary for creativity to emerge as if one is limited to working systematically, only using learned strategies, it is possible to try multiple methods to solve a problem but overlook a creative approach or worse label the problem as "unsolvable," then never explore other means.

Creativity needs time to develop and thrives on experience. Silver (1997) suggested, "Creativity is closely related to deep, flexible knowledge in content domains; is often associated with long periods of work and reflection rather than rapid, exceptional insight; and is susceptible to instructional and experiential influences" (p. 75). Impoverished mathematics experiences that focus only on the utilitarian aspects of mathematics and are without appropriate time to reflect, hinder the development of creativity. Education and experience build mathematical skill but without opportunity an individual's creative potential will remain dormant.

Carlton (1959) analyzed the educational concepts of 14 eminent mathematicians. From her analysis emerged a list of 21 characteristics one might observe in educational settings as indicators of a potentially creative mathematical thinker (Table 1)

She found no single defining characteristic but rather suggested that those who were mathematically creative would demonstrate a subset of these characteristics. As you read through this list notice the references to esthetics, imagination, curiosity and pleasure all of which overshadow references to ability. She identified two types of creative mathematical minds. The intuitive mind and the logical mind that works more from strict definitions, reasoning by analogy and working step-by-step. As support, Carlton cites Cajori's separation of creative minds into two categories, "the alert, quick minds and the slow, although frequently more profound, minds" (Carlton, p. 243). Hadamard (1945) believed that creativity in mathematics requires the intuitive mind with ample time for reflection and incubation of ideas. The message here is that, while fluency is important in mathematics, speed in computational tasks or rapid insight leading to a solution is not; creativity needs time to develop.

Aspects of Mathematical Creativity: Person, Product, Process, Press and a Fifth P – Problem

The Personal Touch

An individual's personality traits such as openness to new ideas, willingness to take risks and persist, curiosity, and wonder all play a role in the development of creative mathematical thought. In an effort to better define the affective aspects of mathematical

Table 1 Characteristics of the potentially creative thinker in mathematics (Carlton, 1959)

1	An esthetic sensibility, expressed in an appreciation of the harmony, unity and analogy present in mathematical solutions and proofs and in an appreciation of the structure of the field.
2	The making up or seeing of problems in data or in situations which arouse no particular curiosity in the other children.
3	A desire to improve a proof or the structure of a solution.
4	A seeking for consequences or connections between a problem, proposition, or concept and what would follow from it.
5	Desire for working independently of both teacher and other pupils.
6	Pleasure out of communicating concerning mathematics with others of equal ability and interest.
7	The speculating or guessing about what would happen if one or more hypotheses of a problem are changed.
8	Pleasure derived from adding to the knowledge of the class by producing another solution or another proof beyond those which the class has considered.
9	Pleasure out of working with the symbols of mathematics.
10	The producing or conjecturing concerning other meanings for symbols than those the teacher has revealed.
11	The making up of mathematical symbols of his/her own.
12	The tendency to generalize particular results either by finding a common thread of induction or by seeing similar patterns by analogy.
13	The ability to see a whole solution at one time or to visualize a proof as a whole.
14	Intuition as to how things should result.
15	A vivid imagination concerning the way things appear in space, the relation of things to each other.
16	A vivid imagination concerning the resulting paths or relationships of objects which have motion.
17	A tendency to speculate concerning unusual applications for the results obtained by the class.
18	The belief that every problem has a solution.
19	Persistence in working on particularly difficult problems or proofs.
20	Boredom with repetition or working of a large number of problems which she/he has well in hand.
21	Ability to perform many operations without thinking.

creativity Dr. Scott Chamberlin (University of Wyoming) and the author are working to develop a personality model of mathematical creativity based on the characteristics defined in **Table 2**.

Many of these aspects can be influenced by training and experience. One area that is frequently debated is the role of domain-specific knowledge. Studies of eminent creators suggests that a period of preparation was necessary before these individuals created new ideas, processes, and products though there are differing views on the nature of the relationships. Regardless of the theory applied, research suggests that a level of mathematical knowledge is required for creative mathematical work that advances the field. That said, mathematical creativity is not limited to new mathematical discoveries. The child who discovers for herself a relationship between problems posed in different contexts with the same underlying mathematical concepts is also creating new mathematical understanding. (For a more in-depth discussion see Kaufman and Beghetto (2009) *Beyond Big and Little: The Four C Model of Creativity*, <https://doi.org/10.1037/a0013688>)

The Role of Product

While a creative idea is the spark, a product is necessary for creativity to be recognized. A product can be in a variety forms but it should be a "... novel and appropriate, useful, correct or valuable response to the task at hand and...heuristic rather than algorithmic" (Amabile, 1996, p. 35). In seeking to develop mathematical creativity, novel and appropriate should be viewed in light of the individual's level of experience. A child's product that demonstrates new mathematical understanding is creative as is the discovery of a solution to one of the Clay Mathematics Institute's Millennium Prize problems. Vastly different in levels of complexity and mathematically knowledge and skill required but both useful and valuable to the tasks at hand.

Boden (2004) discussed the nature of creative products proposing three levels at which creative products emerge: (1) combining existing ideas to create a new product or process, (2) exploratory creativity involving the investigation of new ideas, and (3) transformational creativity; making the impossible possible. At this level reasonable guessing or problems generated by changing an initial constraint or problem input to see what results may lead to creative mathematical products.

An example of this kind of mathematical work can be found in the discovery of non-Euclidian geometries. Euclid built his geometric theorems on five postulates:

1. A straight line segment can be drawn joining any two points.
2. Any straight line segment can be extended indefinitely in a straight line.
3. Given any straight lines segment, a circle can be drawn having the segment as radius and one endpoint as center.
4. All right angles are congruent.
5. If two lines are drawn which intersect a third in such a way that the sum of the inner angles on one side is less than two right angles, then the two lines inevitably must intersect each other on that side if extended far enough.

Mathematicians spent centuries trying to prove the fifth postulate from the other four without success. In the early 1800s a few mathematicians proposed a geometry based on only first four postulates (Carl Gauss, János Bolyai, and Nikolai Lobachevsky)

Table 2 Proposed characteristics of a mathematical creativity personality

<i>Iconoclasm</i>	<i>The tendency to challenge commonly accepted practices in search of other ways to solve a problem</i>
Impartiality	Not bound to one solution approach; open to exploring alternate solution(s)
Intuition/Insight	The ability to sense the nature of problem and envision the outcome without a clear understanding of how to “navigate” the solution path to get there
Investment	An emotional contribution to finding a solution for one or more reasons
Inquisitiveness	A natural curiosity or wonder that seeks a deeper understanding of the mathematics, conjectures and new problems to explore.

leading to the development of a new non-Euclidean geometry. While Euclid’s geometry works well in our everyday lives, the new way of thinking geometrically that resulted from changing one assumption led to new many new discoveries in mathematics and physics as well as additional geometric ways of thinking. Creativity tests assessing flexibility and fluency often evaluate products in this way. [Balka’s \(1974\)](#) Creative Assessment of Mathematical Thinking (CAMT) asks participants to consider how geometric relationships would change if the only thing available to work with was a large ball on which to construct shapes.

The Creative Mathematical Process

In 1926, Wallas proposed a four-stage model of the creative process which parallels Polya’s four-step approach to problem solving ([Table 3](#)).

In the preparation phase the focus is on developing a clear understanding of the problem. What is the desired outcome? What conditions or constraints apply to possible solutions? What information is available? What information is needed? During the incubation phases ideas are considered, explored and often rejected during periods of both conscious and unconscious thought. Plans are developed tested and revised. In this process insight is gained and a solution is illuminated. Once a solution is found it should be verified by looking back asking, does it meet the conditions and constraints imposed? The difference between a creative and non-creative process is the individual’s or group’s ability to avoid constraints imposed by conventional thoughts and applications – time spent exploring and taking risks, rather than just relying on standard practices, rules, and procedures.

All too often the mathematical processes are viewed linearly – a series of steps to follow to a prescribed outcome. The work of both Wallas and Polya are often incorrectly viewed in this way. [Sheffield \(2003\)](#) offers a more iterative model of mathematics with each vertex of a pentagon representing a portion of that process. The vertices are labeled Relate, Investigate, Communicate, Evaluate, Create with each connected to the other four. The interactive nature of Sheffield’s model acknowledges the role of exploration, communication and problem posing plays in mathematical creativity.

The Impact of Press

Mathematical creativity needs a facilitative environment, not an authoritative one. Mathematicians, both those with a lifetime of experience and those just beginning to learn about the discipline, need an environment that provides time to wrestle with problems and persist in exploring ideas, the freedom to challenge the questions posed, and opportunities to work collaboratively to analyze, criticize, and synthesize information. The Math Circle movement in the United States is a notable example of this kind of environment for developing creative mathematicians. These informal communities of practice put students and advanced mathematicians together to explore interesting mathematical topics or problems. Mathematical judgment develops in such experiences and knowledge and intuition are invoked when solving mathematical problems. If one’s experience is limited to “textbook” approaches to solving mathematical problems or lecture based instruction where the individual is an observer rather than an active participant in problem formation/problem solving, there is little opportunity for creativity to develop.

The Role of Problem

If the creative outcome of mathematics is solutions to problems then creativity begins with an interesting question or problem. Speaking before the International Congress of Mathematicians in Paris [Hilbert \(1902/2000\)](#) remarked, “The supply of problems in mathematics is inexhaustible, and as soon as one problem is solved numerous others come forth in its place.” They “...should be difficult in order to entice us, yet not completely inaccessible, lest it mock at our efforts. It should be to us a guide post on the many paths to hidden truths, and ultimately a reminder of our pleasure in the successful solution.” Hilbert’s definition of a problem is not about those that mimic ones previously encountered which can be solved with a known algorithm but rather questions that are of sufficient interest and challenge to stimulate creative response.

So where do these problems come from? Ask a child and the most likely answer is from the teacher or the textbook – someone else’s problems to be solved. Problem formulation or problem-posing is an essential aspect of mathematical creativity. [Silver \(1997\)](#) writes:

Table 3 Comparing Wallas' four-stage creative process model to Polya's four-step approach to problem solving

	<i>Wallas</i>	<i>Polya</i>
1	Preparation	Understand the problem
2	Incubation	Devise a plan
3	Insight or illumination	Carry out the plan
4	Verification	Look back

...in genuine mathematical activity, problems may occasionally be presented for solution by an outside source, but it is more common for them to arise out of attempts to generalize a known result, or as tentative conjectures for working hypotheses, or as sub problems embedded in the search for the solution to a larger problem... It is in this interplay of formulating, attempting to solve, reformulating and eventually solving a problem that one sees the creative activity. (p. 76)

Creativity, Elegance, Imagination – the Beauty of Mathematics

Mathematics provides us with powerful tools that have supported advances in science, engineering, economics, technology and many other fields. As a tool it provides the ability to envision, model and predict outcomes or discover patterns and relationships. For most, the utilitarian aspects of mathematics defines the discipline rather than creative thought and applications that lead to an elegant problem solution or mathematical model, the excitement of the discovery of a recurring pattern in nature, the joy in the symmetry of a geometric construction – all examples of the beauty and mystery inherent in mathematics. In his discussion of mathematical creation, [Henri Poincaré \(1908/2000\)](#) writes:

In fact, what is mathematical creation? It does not consist in making new combinations with mathematical entities already known. Anyone could do that, but the combinations so made would be infinite in number and most of them absolutely without interest. To create consists precisely in not making useless combinations and in making those which are useful and which are only a small minority. Invention is discernment, choice. (2000, p 87)

Poincaré's work ethic followed a strict schedule for his mathematical work, spending 2 h in the morning and 2 h in the evening on his efforts to leaving time for "fruitful unconscious labor" (p. 93). This unconscious labor serves as a filter; "it is capable of discernment; it has tact, delicacy; it knows how to choose, to divine." (p. 91) identifying those ideas "susceptible of becoming conscious, [as] those which, directly or indirectly affect most profoundly our emotional sensibility." (p. 92). This emotional sensibility is a "feeling of mathematical beauty, of the harmony of numbers and forms, of geometric elegance. (p. 92). He goes on to write:

Now, what are the mathematic entities to which we attribute this character of beauty and elegance, and which are capable of developing in us a sort of esthetic emotion? They are those whose elements are harmoniously disposed so that the mind without effort can embrace their totality while realizing the details. This harmony is at once a satisfaction of our esthetic needs and an aid to the mind, sustaining and guiding. And at the same time, in putting under our eyes a well-ordered whole, it makes us foresee a mathematical law. Now, we have said above, the only mathematical facts worthy of fixing our attention and capable of being useful are those which can teach us a mathematical law. So that we reach the following conclusion: The useful combinations are precisely the most beautiful ... (p. 92)

In his article entitled *Mathematics: Creativity Imagination Beauty*, Whitcombe stresses the importance of creativity in school mathematics. While the origins of mathematics are rooted in early mankind's need to count, measure, quantify; human imagination quickly expanded our mathematical knowledge in abstract ways. In doing so our creativity gave us tools to begin to make sense of the universe we live in. The majority of the non-mathematicians' experiences with the discipline consists of the algorithms, rules and procedures in school. The beauty of mathematics, whose traits Whitcombe lists as: structure, form, relations, visualizations, economy, simplicity, elegance, and order, are lacking leading to the misconception that "mathematics is as dry as dust" (p. 15).

All mathematics today is the creative product of human imagination; invented as a means to communicate, to solve practical problems, to entertain, to search for understanding of how the systems in our world connect and function, and to explore ideas we find beautiful and elegant.

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Matthew, Pygmalion, and Founder Effects[☆]

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Glossary

Bradford's Law An area-specific formulation regarding the percentage of total coverage by various journals in a field. When periodicals are ranked in order of decreasing productivity in a field, the sum of articles not produced by the most prolific authors of that field is proportional to the logarithm of the number of their producers.

Cumulative advantage A principle referring to the accumulation of personal or institutional advantages as a result of the social mechanisms of scientists.

Lotka's Law Alfred Lotka's formulation about the distribution of productivity stating that the number of individuals making n contributions in a domain is inversely proportional to n^2 .

Matthew Effect Index (MI) An index showing the national win or loss for citations in positive or negative percentage numbers. The index was formulated as a ratio of the deviation of the observed citation impact from the expected citation impact divided by the expected citation impact calculated from the impact factors of all journals used for publication by a country. The index is a positive number when the observed number of citations exceeds the number of expected citations, indicating a gain situation, and a negative number when the observed number of citations is smaller than expected, implying a loss situation.

One-pass versus Multi-pass Processes: *One-pass process* refers to the consideration of a scientific discovery as being made by the person who performed the last or most critical step. *Multi-pass process* implies acknowledgement of the several contributions and phases of reworking, re-conceptualization or rejection involved in the ultimate discovery by analyzing the interactive networks among scientists.

Pareto's Law Vilfredo Pareto's empirical generalization stating that a minority of a population owns the majority of the resources, while the majority of the population shares the rest.

Price's Law Derek Price's empirical generalization that the square root of the number of all contributors produces half of all contributions.

Self-fulfilling prophecy The situations in which one's expectations can influence an outcome on the expected direction. If one defines a situation as real, it consequently becomes real.

Introduction

Creativity was once regarded as elusive, obscure, magical, and beyond the sciences. In the past several decades the field of creativity studies has become more and more scientific. This implies objectivity, some of which is a result of careful experimentation. Such

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experimentation is usually intended towards the isolation of causes and effects. Not surprisingly, several broad 'effects' are believed to govern creativity. Several terms have been coined to describe effects that explain various mechanisms with relevance to creativity. The effects to be discussed here focus on mainly noncognitive and external aspects of creativity. They are the Matthew, Pygmalion, and Founder Effects. They explain the social mechanisms of scientific creativity, the role of significant others, and the timing or primacy of scientific discoveries, respectively.

Matthew Effect

Creative productivity in sciences is critical for the advancement of our civilization. There has been debate about the relative importance of internal versus external influences on the development of scientific interests. Internal influences refer to the influence of scientists' work as isolated from others' influences. External influences refer to social, cultural, and contextual influences. Creativity is often studied in terms of internal influences: the majority of studies on creativity depend on cognitive and personality aspects of creativity. External influences have been less studied but did become the primary interest of the sociology of science. One result was the concept of the Matthew effect. The Matthew effect describes the reward and communication system of science based on the passage in the Gospel according to St Matthew, which states, "For unto every one that hath shall be given, and he shall have abundance: but from him that hath not shall be taken away even that which he hath."

Put in the context of scientific creativity and productivity, this statement addresses the issues related to the major criteria of success in academia such as publications, grants, and facilities. A dramatic expression of the competition in academia is the phrase 'publish or perish.' According to [Merton \(1968, 1988\)](#), who coined the term Matthew effects, this game is not played fairly, with some people winning every time disproportionately to their superior skills, ability, and work. He pointed to various social processes responsible for the biased evaluation system that leads "the accruing of greater increments of recognition for particular scientific contributions to scientists of considerable repute and the withholding of such recognition from scientists who have not yet made their mark." As a sociologist, he attempted to explain the reward and communication system in science in sociological terms: "the reward system [...] influences the 'class structure' of science by providing a stratified distribution of chances, among scientists, for enlarging their role as investigators."

According to Merton, science is public, not private, and the Matthew effect reflects the social climate that influences the degree to which scientists will be known by others. Merton's view emphasized external influences on recognition of scientific creativity rather than individuals' real potentials. By external influences, Merton referred to the community of scientists that may disrupt the rightful distribution of credits because of their systematically biased ascriptions.

A corollary to this proposition is differential access to facilities and opportunities called misallocation of resources that works in favor of more established and famous scientists. Inequality in the reward system provides further opportunities for known scientists and penalizes the unknown names in the field. The Matthew effect simply represents the equivalent claim as the proposition "the rich get richer and the poor get poorer" in economics. This situation reflects a sort of monopoly held by the famous scientists.

Some of the first evidence of the Matthew effect came from [Harriet Zuckerman's \(1967\)](#) interviews with Nobel laureates in the early 1960s. These indicated that 'ultra-elite' scientists receive disproportionately more credit for their contributions to science whereas obscure scientists get disproportionately little. The distribution of the number of publications is highly skewed: there are many PhD holders who publish one or no articles while a small number of scientists publish hundreds of papers as well as books. Although the skewed numbers can be attributed to other factors such as a scientist's differential ability, efforts, and career expectations, Zuckerman's findings raised some questions about the fairness of the mechanism.

Cumulative Advantage

The idea of cumulative advantage is relevant to Matthew Effects. Career trajectories of the scientists depend, to a great extent, on their cumulative advantage, defined as the social processes that determine the allocation of resources and opportunities such as laboratories, research grants, and talented research assistants and their accumulation among particular scientists and institutions. The advantages can be personal such as reputation and age of the scientists or contextual such as institutions and available resources.

Reputation is the most significant personal advantage. Social processes favor reputable authors over lesser-known authors even when both produced publications of equal quality. Even in collaborative works in which well-known scientists contributed very little, such scientists are credited with most of the work because of their reputations while other contributors receive little credit even if they invested more effort. This is true even when the famous scientist is listed last in cases where the order of authorship reflects the level of the contribution from highest to lowest. This situation persists because of the underlying preconception among the community of scientists that the famous one provided the idea, resources, and connections. This misperception paves the way for other critical decisions that help the known scientists.

When positions become available, they usually are awarded to the scientists with higher recognition, publication, and fame, who are thus able to do more research and further increase their reputations. The less-known scientist, on the other hand, will have a very limited opportunity to stay in the current position because of limited resources and facilities. Once scientists are Nobel laureates, they are Nobel laureates throughout their lives, and this title often increases the influence of their work beyond that work's merits. Their books will sell better because of the 'Nobel laureate' designation, and no journal will want to reject their papers (journals may even ask them to write papers). The ideas in the book will be read by many other people and more people will be convinced about those ideas and cite them in their own works.

Cumulative advantage specifically refers to the benefit of the early bloomers in sciences because of their relative advantages in trained capacities and locations enabling their access to resources. Studies of creativity and age show that researchers who publish earlier attain a greater number of publications than those who publish at older ages. Moreover, early publishers also produce higher quality contributions. This phenomenon can simply be regarded as normal because early bloomers will have more time to produce. From the perspective of cumulative advantage, however, this is related to the precocity bias that promotes early bloomers since early publications are assumed to reflect overall productivity. While there are scientists who cannot keep up their earlier performances and those who perform better in later years, they are fewer in number. The role of cumulative advantage is evident among older and younger scientists. Longitudinal studies of 2000 American scientists from several fields showed that the inequality between older and younger scientists has risen with respect to their number of publications and number of citations, which underlined a marked stratification. [Petersen et al. 2011](#) analyzed the careers of 400,000 scientists and 20,000 athletes and found that past success leads to cumulative advantage and careers are likely to get hindered by inexperience.

As for the institutionalized advantages, lesser-known scientists can break the cycle if they are at major universities where their publications can be disseminated among the elites of the field. Statistics indicate that a good proportion of the research grants are provided to particular universities. Grants often yield more original papers and attract more high-ability novice researchers. Likewise, many of the Nobel laureates work at particular universities such as Harvard, Columbia, Berkeley, and Chicago. In a recent empirical study controlling author quality, journal quality, and article-specific characteristics, researchers found that there are 19 elite universities that have a positive impact on the initial reception of an article and on peer recognition for its contributions. Specifically, scholars affiliated with two universities, Harvard University and University of Chicago, have a greater chance for peer recognition. This finding was limited to the departments of economics, and similar studies can be extended to other departments as well. For example, [Morgan et al. 2018](#) analyzed the role of faculty hiring on the dissemination of ideas in the field of computer science. They found that research studies originating from prestigious universities are more likely to spread better than research of similar quality from less prestigious universities. This effect leads universities hire from prestigious universities that provide them with an “epistemic advantage.”

The critical factor that distinguishes certain scientists from others is the limited awards, opportunities, and facilities provided to scientists. If only three Nobel Prizes can be granted in a year in a given category, this does not mean that only those three scientists may deserve them. However, the recognition of the scientists after they win the Prize differs disproportionately to the quality and significance of their works. The problem is that there are a few prestigious awards that could be granted to many successful and aspiring scientists. Another example is inequality in scientists’ access to laboratory and financial support to maintain their research. Although scientists working in less-known or liberal arts colleges might come up with very bright ideas, they cannot carry out their research because of teaching requirements or lack of facilities. The same situation rules when it comes to publishing papers. Academic journals have strict rules such as publishing only a certain number of articles in each volume – to the extent that only 10%–25% of submissions are accepted in the essential journals. The limited space in the journals tends to be allocated for the prolific minority rather than the novice or less prolific researchers. Furthermore, when two rival scientists with and without articles apply for a grant, their publications will be taken into consideration as well as other qualifications. Success, awards, and opportunity breed further success, awards, and opportunity, just as money breeds more money. Limited prizes, money, and facilities allotted to famous scientists distinguish them from the other colleagues.

The role of reputation for further recognition exhibits itself in the cases of ‘multiples’ when two or more researchers discover the same thing. Even though each scientist who developed or discovered the same thing deserves an equal amount of credit, respect, and recognition, the more famous one is associated with the discovery rather than the others. Some theories, such as the Darwinian Theory of Evolution, are named after the scientist, while many other discoverers who contributed to the development of the theory will not be even known and recalled by later generations. This cycle keeps going for the benefit of the more famous, and the disparity between famous and obscure researchers will increase independently from their capacities as scientists. However, [Donald T. Campbell and Herman Tauscher \(1966\)](#) noted the other direction for the attribution processes for ‘multiples.’ They indicated that scientists with unique or few contributions can be credited with a discovery rather than other scientists with many contributions because singularity of contribution provides unequivocal in the communication.

The Matthew effect is influential in the communication system through its manipulation of the visibility of scientific works. Like the influence of marketing strategies and advertisements for commercial products on their sales, reputations and the quality of previous work increase the possibility of recognition, appreciation, and dissemination of new work in comparison to a new scientist with no distinguished work beforehand. The names of the innovators sometimes overshadow the quality and importance of the innovations. When one thinks of professional conferences in any field, many researchers follow the presentations of the prominent figures in the field whereas novice researchers have fewer followers even when they sometimes introduce more original works.

Formalized Effects

Cumulative advantage may be related to various parallel effects. The so-called skewed distribution of productivity, for instance, was formalized by Alfred J. Lotka as ‘inverse square law’ based on his bibliographical studies in physics and chemistry. This formula states that the number of scientists with n publications is inversely proportional to n^2 . This formula yields a curve with many people with one or zero publications whereas a couple of researchers produce hundreds of publications. If there are 100 scientists with only one paper, there can be 25 people producing two, and approximately 11 with three papers. The number of scientists with a higher number of publications decreases asymptotically. The resulting graph is a left-skewed distribution. This formula implies that approximately 5% of scientists produce about half of all papers and the others share the other half. On the other hand, the

proportion of all contributors with only one publication is about 60%. Even though Lotka's law does not apply to all areas, recent studies about productivity proposed that it is useful in understanding the underlying pattern of author productivity.

Lack of universality in Lotka's law has been addressed by Bradford's law (or law of scatter) which was developed based on journals and articles grouped to identify the number of periodicals related to particular subjects. The process yielded a constant representing the subject area within the following formula, and used to determine the percentage of total coverage by various numbers of journals in a field: $R(n) = N \log n/s$ ($1 \leq n \leq N$), where $R(n)$ represents total number of journal articles, N represent total number of journals, and s is the constant for a subject area.

Derek DeSolla Price proposed another formula for the distribution of scientific productivity. According to it, half of the total number of papers published by N scientists belongs to $\sqrt{N}$ scientists. Assuming that there are 1000 articles in a field published by 100 scientists, 500 of them belong to the 10 most prolific scientists. Price suggested that two-thirds of the scientists publish only one paper and do not produce any more. There was a slight difference in the underlying assumption of his formulization: success increases the probability of further success, but failure does not increase the probability of later failure because lack of publication is a 'nonevent' and it cannot be counted as a publication (any event) is counted. Therefore, he suggested a cumulative advantage distribution, which is an increasing function, rather than negative binomial distribution, which can be an increasing or decreasing function, reflecting the failures and successes.

Another principle that is applied to scientific productivity is Pareto's law (also known as the 80/20 rule) originated in economics. Italian economist Vilfredo Pareto observed that 20% of the population owns 80% of the land in Italy. The remaining 20% of the land is shared among 80% of the population. This imbalance between the 'vital few' and 'trivial many' as described in Pareto principle seems to fit the distribution of the productivity of the scientists as well. A small percent of scientists owns the majority of publications and resources, while the majority of scientists own only a little.

These 'laws' reflect the inequality in productivity. Inequality in citations is even more drastic. Eugene Garfield counted the citations of 19 million articles. Of all articles cited, less than 1% were cited more than 100 times; another 3% were cited between 25 and 100 times; and 58% were cited only once in a 20-year period. Therefore, distribution in citations is more uneven than publications. However, research shows that the inequality in citations is not related to professional age, which was claimed to influence productivity in favor of early bloomers because of precocity bias.

Extensions: Countries and Journals

Other than personal and institutional aspects, the Matthew effect has also been detected at the macro level, leading some to ask if there are Matthew effects for countries. Ideally, scientific publication is only related to the content of the scientific works rather than their regional origins. However, this ideal situation may not be the case because of economic, cultural, and institutional reasons. Thus, a few countries can receive citations predominantly higher than the many other countries, which receive only a few. A Matthew Index (MI; Bonitz et al., 1999) was developed that yields a positive or negative number indicating the win/loss status of the country in citations. The MI index is higher based on the extent to which the observed number of citations can exceed the number of expected citations. The expected number of citations is determined based on impact factors of all journals in a country. The MI index is equal to the difference between observed and expected citations divided by expected citations. The resulting value is a percentage. In a study comprising 40 countries and 2712 journals, only ten countries (Switzerland, Denmark, the Netherlands, Sweden, United States, United Kingdom, New Zealand, Ireland, Germany, and Finland) had positive MI values (higher than expected citations). Analyses of the Matthew effect for countries allowed a new type of journals, called 'Matthew core journals,' which refer to 145 journals accounting for 50% of the citation wins and losses. Those journals were critical for gaining or losing excessive amount of citations.

In an empirical study, the role of the journals, in which the articles are published, was assessed by comparing the citations of identical papers in journals with high impact factor versus low impact factor. Analyses showed that impact factor of the journals played a significant role in getting citations: papers published in high impact journals received twice as many citations as their identical copies published in journals with lower impact factors. Matthew effects as associated with journals influence the citation and therefore visibility of the scientific works.

Evaluation

The Matthew effect was seen as pathology because it conflicts with meritocracy in science. Monopoly is as undesirable in science as it is in economics. However, Michael Strevens (2006) argued that the Matthew effect can be good for society and science. He argued that rewards are proportional to their contribution to society so that contribution to society is maximized. The contribution to society, then, is proportional to its epistemic security, that is, trustworthiness of the discovery or contribution. For example, a new medical treatment for an illness can have good epistemic security after it has been observed to cure the illness successfully. There should be no problem with receiving more rewards if the contributor has resolved an important problem of human beings. Based on this line of reasoning, allocation of credit proportional to the rewards is not at odds with scientific norms since this mechanism is helpful in maximizing science's contribution to humanity. According to this rival hypothesis, the Matthew effect does not seem to violate the fair distribution of credit in particular fields in which the consequences of the discoveries and their epistemic security can be tested. However, this may not be the case in many fields in the social sciences, and the Matthew effect can rule more strictly.

Limitations

The Matthew effect cannot be easily generalized to fields other than the hard sciences because some do not require many resources. For example, in the fields of the arts and literature, the Matthew effect is not dramatically observed in terms of access to resources, since the cost of writing a poem or making a musical composition requires only a pen or a musical instrument in comparison to hard sciences, which require a laboratory and grants. Nonetheless, previous works or publications in arts and literature can still determine the acceptance of future works.

Second, empirical results supporting the cumulative advantage hypothesis can be explained by some other perspectives as well. For example, some explained creativity with multiplicative functions that propose a log-normal distribution because the product of several factors that influence creativity produces a highly skewed distribution, which is different from simple addition of the same factors. The combination of normally distributed factors such as creativity, intelligence, and motivation, yields more complex effects than suggested by the cumulative advantage model.

Third, some models that are more personal in nature explain the continuity of creative productivity better than the cumulative advantage model. Simonton showed that latent factor of creative ability can successfully explain longitudinal stability of the individual differences in sciences. This argumentation takes us back to the beginning of the discussion where internal factors distinguished from the external factors. A seemingly consistent hypothesis relying on external influences can well be explained by a totally different model. Furthermore, [Simonton's \(1998\)](#) rival hypothesis rejects the early bloomer's advantage in producing more output. According to his findings, the age curve shifts but follows a similar pattern for late bloomers when their creative potential is assumed to be zero. It is the creative potential that makes the difference for productivity rather than the age of first publications.

Matthew effect warns that creative productivity in sciences is not a sole function of individual creative ability or skills, and it is manipulated by privileges, reputation, or past achievements of contributors. It is more related to the "establishment" in sciences. There are other mechanisms influencing creative productivity and the next section explores one such effect at the interpersonal level, namely the Pygmalion effect.

Pygmalion Effect

A person's perception is sometimes as important as what they are observing or considering. In part for this reason, a great deal of research has examined the ways various psychological constructs, such as intelligence, creativity, or personality, are understood by various lay groups. These understandings represent what are called implicit theories. Explicit theories, which refer to views held by scientists and researchers, are shared, tested, disseminated, and discussed. All of the theories mean they are explicit, and they may have impact on scientific work and theory construction. Implicit theories are also potentially important. They are stable yet not shared or tested. The implicit theories of teachers about creativity are extremely important. They no doubt shape teachers' expectations about students, and those expectations are critical for students' academic achievement and intellectual growth.

Creativity is influenced by interpersonal factors and Pygmalion effect is one such factor that points to the importance of beliefs and expectations of one for others. The Pygmalion effect occurs when expectations lead to actual changes in behavior. The label Pygmalion comes from a Greek myth that tells the story of a sculptor from the island of Cyprus who carved an ivory statue of a woman. She was so beautiful that Pygmalion fell in love with her. Pygmalion treated the statue as if it were an actual woman and wanted it to be real. He prayed to Aphrodite, the 'goddess of love,' who brought the statue to life. Social psychologist Robert Rosenthal was the first to name this effect, and thus it is also known as the Rosenthal effect ([Rosenthal & Jacobson, 1968](#)).

The role of expectations on human behaviors is discussed not only in the concept of the Pygmalion effect. There are other effects related to expectations, such as the Hawthorne and Placebo effects. However, the concept most closely related to the role of expectations on human behavior and that on which Rosenthal bases his definition is Self-fulfilling Prophecy. Understanding the Pygmalion effect is easier when self-fulfilling prophecy is well-understood.

Self-Fulfilling Prophecy

Like the Matthew effect, the concept of self-fulfilling prophecy was introduced by Robert K. Merton (1968). He defined it as the situations in which people's expectations can alter realities in the expected direction because the target person acts in accordance with the expectations. Self-fulfilling prophecy highlights the importance of definition of situations: "If men define situations as real, they are real in their consequences." This principle, however, works in many cases of subjective reality regarding human affairs, but not for natural affairs. Note that the definition of the situation does not have to be correct. Hence, a false definition of the situation may trigger a new behavior, which can make the false definition become true.

There are plenty of examples self-fulfilling prophecies. Think of the banking system. Can a bank go bankrupt because of rumors that it is going bankrupt? According to self-fulfilling prophecy, that is very possible! If a good majority of the investors are convinced that the bank is going to collapse soon and that they may not be able to withdraw their money unless they do that as soon as possible, it may become a reality. Their expectations, which were not true beforehand, led to a new behavior, which, in turn, resulted in what they expected. Some researchers explain underachievement of the black population in the United States with the concept of self-fulfilling prophecies. Prophesized underachievement becomes a reality.

There is empirical support for the concept of self-fulfilling prophecy. Ray C. Rist (1970) was interested in teacher–student relations based on the premise that students’ variations in success, rewards, and creativity should be considered in a larger scope, the social structure surrounding them. He, therefore, argued that the dynamics of the interaction are not uniform and hypothesized that initial presuppositions of teachers about their students’ abilities and their expectations are critical for academic achievement. Teachers, informed that certain students were ‘fast learners’ or ‘slow learners,’ treated those two groups of students differently and had different expectations. He observed that teachers have recognized that their expectations were biased and influenced by their social status and ethnicity.

How is it possible? One answer is that these expectations about others are communicated to those who are expected to behave in particular ways and that those who receive the message then react in accordance with this message and consequently confirm the expectations. The power of the message communicated is related to the subjective status of the message sender. If the person who claims a prophecy has high status in the eye of the message receiver, the message is perceived and followed as if true.

One could question the generalizability of Rist’s findings. De Boer et al., 2018 conducted a meta-analysis on the impact of teacher expectations on learner outcomes such as achievement. Interventions that focused on altering teacher behavior, enhancing awareness on the impact of expectations, and the beliefs related to the expectations improved student achievement.

The overlapping aspects of the Pygmalion effect and self-fulfilling prophecies are clear: the power of expectations. But how are they different? The Pygmalion effect could be defined as a self-fulfilling prophecy that occurs at an interpersonal level. “One person’s expectation for another person’s behavior can quite unwittingly become a more accurate prediction simply for its having been made.” Whereas self-fulfilling prophecies explain the influence of beliefs on the consequent behavior, the Pygmalion effect specifically focuses on how one person’s expectations about another person’s behavior can turn out to be a reality just for having been expected.

The Pygmalion effect is more intriguing when it is applied to creativity. First, there are some settings, like school or business environments, in which interpersonal relations markedly influence creativity. In those settings, power relations and the status of the others might play a significant role on the manifestation of creativity. The question above can be altered with that in mind: “What would happen if, for instance, teachers could change their expectations about the creativity of their students?” “Could this lead to a positive change for the students?”

Teachers and Students’ Creativity

Teachers’ expectations are especially important when it comes to creativity because studies show that there is already a mismatch between teachers’ perceptions of creativity and creativity as a construct and its correlates. Erik L. Westby and V. L. Dawson (1995) examined teachers’ understanding of creativity in comparison to the definition of creativity in previous studies. Teachers were also asked to identify their most and least favorite students. They found that teachers’ perceptions of creativity were different from those in the prior studies. Interestingly, students who are unappealing to teachers exhibited the characteristics of creative people. Teachers tend to see their favorite students as creative students, whereas they do not regard their least favorite students as creative. It is not hard to imagine that teachers’ expectations about those favorite but not very creative students will be high and that the expectations about those not favored but nevertheless creative will be low. In other words, the Pygmalion effect seems to influence some students but not all, especially the creative ones.

R. Pippert (1969) conducted an experimental design to test the Pygmalion effect for creativity. Torrance Tests of Creative Thinking were administered to 20 fourth-grade and 20 sixth-graders who were randomly assigned to experimental groups. The results of this test were given to teachers as pretest results so that they could ‘know’ which students were ‘highly creative.’ Teachers were encouraged to observe those highly creative students for their creative potential. Those names were brought up again over a period of several months. The pretest was administered again and results showed that students in the experimental group classified as creative improved their creativity scores more than those in the control group. In interviews with teachers, they were asked if they suspected the stated purpose of the study. The creativity scores of pupils whose teachers did not doubt the stated purpose were higher than the pupils whose teachers did.

In another study by Rosenthal et al. 1974, all children in grades one through six received a test that supposedly discovers creative potential. Also, they were asked to draw a man and to draw as many things as they could. Twenty percent of the children were randomly selected as ‘bloomers’ in terms of creative ability, and the teachers were informed that those children had unusual creative ability. The tests were administered again at the end of the academic year, and classrooms and teacher–student interactions were observed. Even though no overall difference was found for teacher expectancy effect, ‘bloomers’ in the fifth grade performed at higher levels than those not identified as unusually creative. Even though those results did not convincingly demonstrate the Pygmalion effect for creativity, another finding from this study underlined the role of teachers: the students with the highest score gains had teachers who are likeable, interested in children, enthusiastic, professional, and inclined to give encouragement.

Prophesying Creativity

Can we manipulate the creative performance of people by changing our expectations about them in other settings? An empirical study by Samuel J. Marwit and James E. Marcia (1967) provides an answer. They used responses to inkblot tests as an

indicator of intellectual ability. Since inkblot tests involve obscure stimuli, the responses to them can be viewed as a measure of divergent thinking ability, which has been regarded as a good estimate of creativity. They hypothesized that the number of responses given by a subject is influenced by the examiner's expectations. In the study one group of examiners predicted many responses while another group predicted few. The results showed that subjects of the former group provided 54% more responses than the latter group. In another study, examiner's expectations were manipulated regarding the possible responses from the inkblot tests by letting a group of them know that more animal percepts should be obtained than human percepts. The other group was told the opposite. The ratio of animal to human percepts was 33% higher in the former group than in the latter group. These two studies indicated that expectations about others can influence the creative responses as well as change the content of the responses.

Pamela Tierney and Steven M. Farmer (2004) tested the role the Pygmalion effect has on employee creativity in organizations. Supervisors who have high expectations about employee creativity were perceived by employees as supportive of creativity. The correlation between supervisor and employee expectations for employees' creative performance was moderate and significant. According to this study, expectations manifest their influence through intermediate steps like motivational effects and self-efficacy. Employees' self-efficacy on creativity mediated the Pygmalion effects (supervisors' expectations). This means employees who were seen as highly creative by their supervisors and reported about themselves that they had a strong creative capacity demonstrated more creativity in their works. This finding confirms the proposition that the expectations of others are communicated to them.

In another study in an organization setting, researchers hypothesized that leadership, individual problem-solving style, and work group relations influence innovative behavior through their influence on perceptions of the climate for innovation: the more supervisors expect innovative behaviors, the more a subordinate becomes innovative. The analyses showed that expectations of supervisors influenced individual innovative behavior even though this effect is specific to certain tasks such as technical tasks.

Studies of the role of expectations on creativity showed that assuming creative potential in everyone is conducive to creativity. Recognizing the significance of Pygmalion effects for creativity, thus, would be a significant addition to the implicit theories of teachers and supervisors.

Founder Effect

Recall that the Matthew effect emphasized the social mechanism of sciences that favor the famous scientists. Thomas Nickles (1994) defined another term, the Founder effect, also known as the Historical Priority effect, which refers to the importance of the timing or primacy of the scientific works. Recognition for creative productivity or a creative contribution sometimes comes from later works that build on early works that are not well-known. The idea is that some works of obscure scientists can make them famous just because of the triggering effect of the works. The Founder effect is best understood along with the Matthew effect and sometimes competes with it. Both involve the distribution of credit among discoverers. The Matthew effect highlights the role of reputation and other advantages on the distribution of credit while the Founder effect underscores the role of initiation or foundation of a new line of thought. The Founder effect represents cases where scientists made a name for themselves just because their work launched a new idea or series of research and triggered others scientists' works that in turn may have yielded a discovery. Hence the founder may not have him- or herself actually discover the key finding.

According to Nickles, two different models of creativity are possible: traditional/enlightenment and romantic models. He argued that all discoveries fall into one of these. The Enlightenment model relies more on empirical proofs, which are evaluated through inductive or deductive reasoning. Because of heavy emphasis on rational means, scientists are viewed as calculating engines. Romantic reaction to enlightenment view relies more on intuition. Instead of tracking the empirical evidence through rational processes, sensitivity to the lack of fit on the whole is viewed as responsible for the discovery. Oft-cited 'Aha!' moment in the creativity literature was a romantic understanding of creativity.

The two perspectives merge on their conception of science as a one-pass process. This suggests that scientific works are presented as if they become knowledge when they are finished like a snapshot of the final scene without elaborating on the processes of reworking, reconceptualization, or rejection. This is a simplification that reduces a whole process into 'scientist A made discovery Z' thinking. In actuality, scientific discovery is a multi-pass process. Several investigators usually make contributions, additions, or reinterpretations, each taking the problem into a different point. Because of the heavy cognitive overload involved with multi-pass thinking, and the emphasis on the individual in the history of science, it is easy and typical to recall the 'heroes' of science and ignore the complex networks that each added small blocks to the huge building. Jose Ortega y Gasset (1932) actually proposed that modern science owes much of the contribution to mediocre scientists who constitute the majority of the community. One last point about Founder effects: the initial step that provides the initiators with credit can be in the wrong direction with respect to scientific correctness, or it may be misunderstood by the real contributors who followed the founder. Some prominent examples for Founder effect are Max Planck and Frederick Banting.

Example Cases

Max Planck is known as the discoverer of quantum of energy because of Einstein and Ehrenfest, who started their works with (and misread) Planck's works. The discovery of quantum of energy, in fact, emerged years later, and Planck's solution to the problem was

abandoned. Max Planck initiated his work and got credit because he coined the term 'quantum,' while his solution eventually was not accepted. In this example, association of the discovery of quantum energy with Planck rather than Einstein can be explained by Planck's reputation (therefore, the Matthew effect is relevant in this situation because Einstein was not well known at that time) as well as his initiative for a new line of thought even though his naming was just accidental and [his] solution was not correct. In Planck's case, both Matthew and Founder effects operate together.

Frederick G. Banting's case (along with Charles Best) represents how an enthusiastic but unknown scientist can get credit for his initial work that gave birth to a significant discovery. Even though Banting was credited with the discovery and received the Nobel Prize, his work was not on the right track in terms of the resulting discovery. His hypothesis, based on the idea of duct ligation to isolate internal secretion in the pancreas, did not comply with the established facts in physiology. He was correct in addressing the problem (which concerned enzyme action) even though his work did not solve it. However, that deficit did not change the fact that Banting's idea was the first step that led other researchers to contribute to the solution. Banting was an unknown scientist when he came up with his idea. Therefore, his case represents the sole operation of the Founder effect without the Matthew effect.

The Founder effect is important to know because recognition for creative contributions may be delayed until they lead to other major contributions. The delay may take so long that some contributors do get credit in during their lifetime, which is called post-humous recognition. A recent example of the Founder effect in the field of creativity is the standard definition of creativity. The two-component definition of creativity involving novelty and usefulness is credited to different researchers and Runco and Jaeger traced the historical roots to Morris Stein's work in 1953. Stein gets recognition recently because he was the first to use two essential key terms for the first time as a definition of creativity.

Similar to the Matthew effect, the central idea of the Founder effect is the suggestion that there is more innovation in science to be recognized and, therefore, more credit to be shared among many more contributors. Nickles noted that the problem of cognitive overload can be handled by deemphasizing the individual scientists so that the role of social 'state variables' and 'forces' can be better understood.

Conclusion

Creativity is more than an individual effort and researchers recognized the role of social, contextual, societal, or system-wide influences on creative productivity. Some of these effects were objectively observed and reported in scholarly works. This chapter focused on three of these effects. First, the Matthew Effect underlines how the established system in sciences may reward some with early success or earned or presented advantages while penalizing others without them, leading further discrepancy among scientists with same or similar level of creative potential. Second, the Pygmalion Effect calls attention to the power of beliefs or expectations for creative productivity where individual creative productivity increases with higher expectations of others regarding one's creative potential. The Founder Effect refers to the critical role of earlier creative contributions that served as foundation for later creative works even though the link between the two may not be obvious or early works were not necessarily established. These three effects point to the forces above individual that may enhance or suppress their creative productivity or the recognition for it. Therefore, it is critical to be aware of such factors because they hint at strategies to maximize creative productivity of an individual or group.

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Measurement: Computerized Creativity Testing and Scoring

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The past two decades have ushered in a new era in the computerized measurement of creativity. This entry focuses on how computers are being used to measure and assess creativity both in laboratories and in the field. The emphasis is on both the computer environment—the ways are computers, or more broadly electronic devices used to measure creativity—and on the technical challenges of computerized scoring. The latter topic has seen the most growth in the area of computerized scoring of responses to verbal divergent thinking tasks. Other innovations in technology are enabling the collection and analysis of non-verbal creativity tasks, though this effort is still in the early stages of development.

The entry is organized as follows: first, the application of computerized scoring to divergent thinking tasks will be discussed. Following that, several novel paradigms for collecting creativity data in a variety of virtual environments will be discussed. Where appropriate, suggestions will be made as to how scoring should be carried out, but the purpose of this entry is not to declare winners and losers. Rather, the emphasis is on providing the reader with several leads for exploring how computers are best used in various laboratory and applied research settings.

Automated Scoring of Divergent Thinking Responses

A recent review of creativity measurement (Snyder et al., 2019) revealed that over 50% of creativity studies use some sort of divergent thinking (DT) test. The popularity of these tests likely stems from their ease of administration, but also because ideation is the aspect of creativity that can be measured across the spectrum of creative abilities (Runco et al., 2001). However, scoring DT tests is sometimes quite laborious. Several scoring metrics have been proposed including fluency—the quantity of non-redundant responses, flexibility—the number of different categories or category shifts in response arrays, originality as statistical rarity—points are awarded to responses that are not common within the sample, and originality as subjectively scored by raters. It is relatively simple to use computers to tabulate fluency scores, but the other metrics are not as straightforward. For example, Reiter-Palmon et al. (2019) noted that there is a hidden source of “researcher degrees of freedom” in many DT studies involving the organization of responses into discrete categories. For ease of further scoring, researchers might group the following alternative uses for a brick into the same category: “prop a door open,” “lift for exercise,” “hold papers in place” → *use as a weight*. This is usually a manual and tedious process that necessitates the use of multiple scorers for ensuring reliability.

The grouping of similar responses affords the variations on uniqueness scoring that quantify originality or creativity in terms of the statistical rarity of a person’s responses compared to the sample. This can be done by hand or using simple computer algorithms by simply constructing a look-up table with response categories aligned with either the percentage of the sample that listed responses in the categories, or with the points to be awarded to rare responses, as is done in uniqueness scoring. Since flexibility scoring relies on counting either the quantity of categories or category switches in a response array, categorization of responses is essential. However, the construction of computer algorithms for categorizing responses is not a trivial matter.

The difficulty in automating a categorization or *clustering* algorithm is that the responses generated during DT do not fall into neatly organized taxonomic categories. Despite this difficulty, Olteteanu et al. (2019) illustrated that it can be done by using a variety of natural language processing techniques. They applied the custom algorithm to normative data from participants who generated creative uses for 420 commonly used objects and found that it performed reasonably well. The resulting database is still rudimentary, as an analysis using the clusters on existing datasets revealed that nearly 50% of responses did not fall within the currently identified clusters. However, it is likely that larger normative efforts will enable the construction of a more inclusive set of clusters that will enable automated flexibility scoring of the alternative uses task.

Semantic Scoring

Notwithstanding Olteteanu et al. (2019) effort, the vast majority of attention in automated scoring of divergent thinking tasks is in automating the scoring of creativity itself outside of uniqueness and flexibility. In this entry, the term *semantic scoring* will be used to describe this process. The term illustrates the metrics' theoretical foundations in information retrieval and semantic memory research. That is, semantic scoring algorithms are rooted in the cognitive science of *word meaning* and as such, their validity is partly a function of the validity of the theoretical underpinnings of the approach. The objective of this scoring approach has generally been to capture the divergence (e.g., Acar and Runco, 2014) of DT responses or the remoteness of the associations that comprise the responses (e.g., Hass, 2017a). This can be done in a variety of ways, as the next few sections will illustrate. First, however, it is important to provide an overview of the theoretical and computational underpinnings of *semantic representations*—computational cognitive models of semantics.

An Overview of Computational Semantics

There is no current consensus among cognitive scientists as to the best method to computationally represent word meaning, and often the applications of a particular method dictate the representational method (Mitchell and Lapata, 2010). In addition, the quality of the representation is very much a function of source of the information used to construct it—the *corpus*. Corpora are collections of documents composed of words from some language, and a non-trivial task is converting the corpus into the semantic representation. For creativity researchers, misspecification of a corpus can lead to missing data such that a word used by a participant in a response may or may have actually occurred in the corpus (e.g., iPad will not appear in any corpus based on older textbooks).

Just as important as the form of the underlying representation of words is the means of representing *relations between words*. For example, two popular systems of representation are *vector-based representations*—word meaning is represented as coordinates in a high-dimensional semantic space, and *network representations*—word meaning is represented within a network composed of nodes, with the pattern of activity of the nodes corresponding to word meaning (Griffiths et al., 2007). In vector-based representations, remoteness of associations can be computed in terms of word similarity, which itself can be computed in terms of the cosine between word vectors. In network representations, words can be compared in terms of their patterns of activation, or in terms of the shortest length of the path between them and some other part of the network. The overarching theme here is that simply comparing the meaning of words using computational semantics is a non-trivial task.

An extra complication when using semantic scoring with DT responses, is that those responses are hardly ever single words. Instead, common responses to alternative uses prompts (e.g., brick) might contain a verb, noun, and an adverb (e.g., “use to gently prop a door open”). Vector-based representations can handle such phrases by simply computing the vector-average (centroid) over the words in the response, but that result can lead to a sort of blend of the word meanings that may not yield good specificity of the phrase meaning (Mitchell and Lapata, 2010). Network representations can, in theory, handle phrase-level data, however, fewer researchers have attempted it (but see Georgiev and Georgiev, 2018). As such, the majority of applications of semantic analysis to DT responses are rooted in vector-based semantics, and that will be the focus of discussion.

Applying Semantic Representations to DT Responses

Forster and Dunbar (2009) illustrated a key aspect of the use of vector-based semantics for scoring alternative uses responses: the basis of comparison matters. In their study, they used latent semantic analysis (LSA), a vector-based representation of word meaning constructed using matrix transformations to reduce the dimensionality of a term-document matrix—a representation of word co-occurrence in a corpus that ignores word order (for more detail see Landauer and Dumais, 1997). The result of the dimensionality reduction is a set of factors, not unlike those distilled from factor analysis, and the “scores” of words on each factor comprise the coordinates of the word-vector. Vectors are then compared using the cosine similarity metric, which provides a relatively good analogue to human similarity judgements (Landauer and Dumais, 1997).

Forster and Dunbar (2009) compiled several different metrics, each employing the cosine similarity between various responses. The two most relevant measures were two variants on originality: “relative” (quotes added) originality—originality defined by comparing each response to a vector average of 25 randomly selected responses, and “common-use” originality—originality defined by comparing each response to the most common use for the object given by a separate set of participants. Both measures had a positive association with fluency: the more fluent a participant was, the more similar, on average, his or her responses were to either the common use of the object or to other participants' creative uses. In addition, elaboration—the sheer number of words in each response—was negatively correlated with similarity. However, only the common-use measure correlated highly with human judges' ratings of the responses. This suggests, that at least part of what human judges assess when rating the originality or creativity of alternative uses responses is the similarity (or lack thereof) between a given creative use and the common use for that object.

In two analyses Hass (2017a,b) investigated a similar scoring procedure. Rather than solicit normal uses for objects, Hass used LSA to compare DT responses to composite dictionary definitions of the prompt objects as a means to standardize the technique. Hass (2017a) illustrated that there was a reasonable correlation between semantic distance and human judged originality of responses using a previously validated dataset. In addition, he showed that participants with higher fluid intelligence scores produced more semantically distant first responses indicating that the semantic scoring technique captured previously identified

relations between DT, remote associations, and fluid intelligence. Hass (2017b) further showed that the semantic similarity of DT responses decreased across the first few responses, which is consistent with the serial order effect in DT (Hass and Beaty, 2018). These results lend further support for the use of LSA-related semantic scoring for capturing critical aspects of the DT idea generation process.

Despite these positive results using LSA methods for semantic scoring, there are some issues with the methodology and several alternatives. First, the number of words in a response can bias the LSA derived scores leading to issues in interpreting results across studies (Forthmann et al., 2018). This is particularly important if LSA is used for scoring other verbal DT tasks such as the consequences task that generally lead to wordier responses. Harbison and Haarmann (2014) provided scenarios to participants such as “a light in the darkness” and asked for creative responses to the scenarios. They then compared the performance of LSA-based scores with scores based on Pointwise mutual information (PMI). PMI is an information-theoretic metric that is based on an “n-gram” analysis of a corpus. An n-gram analysis entails tabulating sets of n words in a corpus in order to derive the transition probabilities between words.

Harbison and Haarmann showed that PMI-based analysis outperformed LSA when used to examine the first content word in responses. However, PMI cannot handle phrase-level data in the same way that LSA can, and relies on a much larger corpus than LSA does, so it is unclear how effective PMI can be in scaled up applications. Finally, a related algorithm for processing corpora, latent Dirichlet allocation (LDA), shows some promise for augmenting semantic scoring techniques as evidenced by its use in analyzing real-world idea generation (Chan and Schunn, 2015). Deriving valid DT metrics using LDA is more complex than using vector-based comparisons because the result of LDA is not spatial representation but rather a set of “topics” comprising different words in the corpus (see Griffiths et al., 2007). These topics represent a kind of feature-based representation similar to classical theories of object recognition, and preliminary analyses show that the method can at least represent the features of various DT object domains (Hass, 2018). However, there is still more to do to demonstrate that these so-called “topic models” can be validly applied to DT scoring.

Beyond vector-based representations, Acar and Runco (2014) found success quantifying the remoteness of associations contained in DT responses using information from different databases that represent word associations: WordNet, the Word Association Network, and IdeaFisher. WordNet (Princeton University, 2010) is a database that represents word meaning using conceptual and lexical relations between words rather than computing relations via co-occurrence data, as is done with LSA. The database lists “synsets” for words, which are like synonyms are more complex, and include other lexical information beyond synonymy. Similarly, the Word Association Network (<https://wordassociations.net/en/>) uses a set of algorithms to produce sets of associates for thousands of English words, as does the IdeaFisher tool, though the information about how these tools compile the lists is proprietary. In all cases, the tools generate a list of associates for English words, but the underlying representation is not vector-based.

Acar and Runco (2014) used the three databases to construct a categorical scoring scheme for DT responses: “close associates” were responses with all words appearing in the databases, while “remote associates” were responses with no words appearing in the output from the databases. Since WordNet lists were generally much longer than the other two databases, Acar and Runco added a “moderate” category and responses in that category were those in which at least one word appeared in the WordNet lists. The scores derived from each database showed good internal consistency, and were moderately correlated with self-reported creative “attitudes and values.” In a follow-up study, Beketayev and Runco (2016) again showed that association-based scoring was reliable, and that a new metric: item originality—an average of the association statistics across 12 association networks—was also reliable.

Though the details of the methods are unclear, Beketayev and Runco provided evidence that algorithmic originality scores are possible to compute without the use of LSA. Indeed, in a recent study, Georgiev and Georgiev (2018) successfully used a WordNet-based method to quantify divergence and convergence in real-world creative problem-solving conversations. Georgiev and Georgiev (2018) formalized several graph-theoretic and information-theoretic metrics for further use, and there is clear potential to adapt these methods to score specific tasks used by psychologists.

Summary

Despite some lack of clarity on what the gold standard should be for assessing the use of semantic scoring methods, there are clear advantages from such approaches. LSA-derived scores seem to capture some critical aspects of the idea generation process, and illustrate construct validity and reliability. Network analysis also holds promise for scoring DT responses, but given that such an approach has only begun to penetrate psychological research, it will likely take more time to validate such methods. Early efforts at automating the categorization and clustering process implicit in many DT studies are also showing promise, and present a practical way for standardizing the cleaning process used by most DT researchers. However, the most important three aspects to consider when using these methods are the corpus used to train the representation, the form of the representation itself, and the mathematical and conceptual formalisms at the heart of the algorithm’s details. Without consideration of these details, semantic scoring techniques may lack some of the validity shown in the reviewed analyses.

Use of Computers Beyond Divergent Thinking

Though DT is often the target of computer-based assessment and scoring, researchers have begun to apply computerized techniques to creativity tasks beyond verbal divergent thinking. These applications generally represent the use of computers for collecting data

in novel experimental paradigms or over the internet. Both of these approaches are extremely important for the broader application of creativity measurement and assessment in industrial and educational settings and for the continued push for more domain-specific, and ecologically valid creativity tasks for use in laboratory research. It should be noted that several analyses have shown that DT tests can be reliably measured via the Internet, with the same validity as face-to-face DT testing (e.g., [Acar and Runco, 2014](#); [Hass, 2015](#)). Rather than discuss those efforts, the remaining sections of the paper will focus on computerized and Internet facilitated brainstorming, as well as domain-specific applications of computers to creativity research.

Group Brainstorming

[DeRosa and colleagues \(2007\)](#) conducted a meta-analysis of electronic group brainstorming research that compared the use of computers in the process to face-to-face group brainstorming as well as control conditions in which electronic group efforts were compared to “nominal” electronic groups – averages across individual brainstormers working at computer terminals. They concluded that though electronic groups brainstorming together via computer applications outperformed face-to-face groups on the quantity and quality of ideas produced, there was little difference between groups using electronic collaboration software, and the nominal groups, who did not interact via software. However, further analyses revealed that group size moderated the effects such that electronic group brainstorming was superior when group sizes were large. The major takeaways from the analysis were that use of collaborative software in medium to large size groups improves the quantity and quality of ideas most likely because such software acts as an external memory device (all generated ideas are displayed to users through the session) and can reduce pressures of social etiquette that might prevent the voicing of ideas in face-to-face sessions.

The merit of electronic brainstorming work is that they seem to afford the study of idea-generation problems with more complexity and domain-specificity than classical DT tasks. However, it should be noted that in all of the studies reviewed, scoring was carried out by hand, with limited effort to apply semantic algorithms, even though verbal responses were almost always collected. Indeed, in most cases, brainstorming research uses the same quantity and quality metrics outlined by DT researchers (fluency, uniqueness, and subjective creativity ratings). Given the different origins of DT and brainstorming, it is not surprising that there is limited cross-talk between the two research fields. With the advancements in algorithmic scoring of DT responses, there is fertile ground for growth of algorithms to sift and score responses collected via electronic brainstorming software.

Domain Specific Applications

One of the most promising areas for further work in computerized creativity measurement and assessment is in the development of non-verbal tasks and domain-specific tasks that go beyond brainstorming and DT. As with verbal divergent thinking data, there is a need for automated scoring of verbal responses in all areas of verbal creativity. [Wang et al. \(2008\)](#) illustrated that vector-based representation of responses to a problem in earth science (debris flow) could be used to quantify both problem finding—a surrogate of exploration or divergence—and problem solving; ostensibly convergence. Participants in Wang and colleagues’ study were given a scenario describing the debris-flow hazard represented by an ensuing mudslide. They were then asked to two questions: “what are the possible factors underlying debris flow hazards” and “what are the possible solutions for preventing debris-flow hazards.” Students were encouraged to generate as many responses as possible for each question. Responses were converted to a vector-space model similar to that used for LSA. Rather than use an underlying corpus, Wang and colleagues used the vector space model to categorize responses based on human coding using a heuristic method and two machine learning algorithms: a support-vector machine classifier and a regression approach. The aim of each method was to output a grade for each participant that quantified divergence and convergence. All three methods were able to provide output that fit well with human-graded responses, though the algorithms used were more complex than those used for LSA-based semantic scoring. As with the LSA-based approaches to DT scoring, Wang and colleagues emphasized the quality of the training data and human coders’ work as critical to the success of these algorithms. However, the effort to tailor algorithms to a specific domain in education illustrates the potential for more work in this direction.

In the debris-flow study, Wang and colleagues identified problem-finding as an important aspect of the creative process. Problem-finding—also known as problem identification or problem construction (e.g., [Reiter-Palmon](#) this volume)—is not explicitly measured in DT tasks. Tasks that require participants to indicate their thoughts about the problem domain itself, such as in the first question in the debris-flow study illustrate that search of knowledge may be an important determinant of creative problem solving (see also, [Hass, 2017b](#)). In a novel approach to information search, [Kerne et al. \(2008\)](#) combined “information discovery” with creative ideation using computers. Psychology students were asked problem-finding questions (e.g., “what psychological factors can influence a person’s career choices”) and presented with a computer interface that allowed them to search for information related to the question and compile a hybrid text-and-image based “answer” with specialized software (combinFormation). Students’ answers were then scored with a rubric for “emergence ... qualities [that] come newly into existence as a result of novel combinations of elements” (p. 468). Though the task of electronically assessing emergence was not undertaken by Kerne et al., their use of a search mechanism and specialized software for answer composition represents an exciting avenue for future work across domains.

Nearly all of the methods reviewed involve verbal solutions to verbal problems. However, a few researchers have made significant headway on this front. For example, [Barbot \(2018\)](#) illustrated the feasibility of measuring fluency and response time data

using computerized versions of figural items similar to items on the figural form of the Torrance Tests of Creative Thinking. Participants drew their responses into a custom interface which then tracked response time as a means to segment the drawing process into exploration, production, and verification phases. Though Barbot's report was a feasibility study, the effort illustrates the potential of this assessment paradigm, especially in studying children and other populations for which verbal ability may be underdeveloped.

Muldner and Burleson (2015) engineered a computer drawing environment in which participants worked through geometric proofs with both text and figures. Muldner and Burleson also used eye-tracking, EEG, and skin conductance sensors while participants constructed their proofs. Though the creativity of the proving process was quantified with traditional measures (fluency, flexibility, and uniqueness) the combination of creativity and sensor data allowed for examination of correlations between creativity scores and the data collected via the sensors. There were significant differences in saccade patterns between participants with high creativity scores and those with lower scores on the proving tasks. Though the sample size was small, the study, like Barbot's method, demonstrated how traditional creativity scores can be integrated with domain-specific, non-verbal problems represented with computer technology.

Conclusions and Future Directions

Much has transpired in the last decade to move creativity measurement and assessment into the digital age. Though emphasis was initially on computerizing and automating verbal divergent thinking tests, transdisciplinary efforts, especially in STEM and design fields, are yielding a variety of applications of computerized methods to domain-specific tasks, electronic brainstorming, and creativity support systems. Though the latter was not the focus of the entry, it remains an important part of the effort toward understanding how computers should be applied to creativity research questions.

Not surprisingly, there are still difficulties in fully automating the evaluation aspect of many creative tasks. Semantic scoring of verbal creative ideation has seen the most development, but there is still much work to be done to scale up semantic scoring efforts. In addition, many domain-specific applications feature the novel use of computers as data-collection systems, but still rely on human-mediated evaluation procedures. It may not be possible to fully remove the use of judges or coders from all scoring processes, and indeed, human coding plays an important role in the design of any machine-learning or prediction algorithm (Wang et al., 2008). That said, using computerized means to collect creativity data at the very least reduces the load on researchers by providing structured data to analyze. Notwithstanding the limitations still inherent in computerized data collection and analysis in creativity research, the future is certainly very bright.

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Measurement: Creative Products

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Introduction

Creativity, it is commonly argued, can be analyzed by looking at creative products, creative processes, creative personalities, and creativity-enhancing environments (Rhodes, 1962). All are important, but only one is essential: creative products, without which the term “creativity” becomes meaningless. A creative process, creative personality, or creativity-enhancing environment that never produced anything that might be judged creative would belie the adjective “creative.” In contrast, an artifact deemed creative can be justifiably described as such even if there was no evidence of any creative processes, creative personalities, or creativity-enhancing environments involved in its production. Even nonhuman creators — including both animals and computers — can be creative in the sense that they produce things that appropriate experts might judge to be creative.

Consider what would be required to make a case that a particular thinking process, personality, or environment was in some way a creative thinking process, creative personality, or creativity-enhancing environment. One might build such theories, but to test them there would at some point need to be a connection of some product that could be judged to be creative. Unless someone actually does something that might be judged to be creative, it is hard to argue that the person, the thinking processes that person might use, or the environment in which that person is working is creative in any meaningful or defensible sense. The product might be some lasting creation or a more ephemeral product such as an idea, but unless the thinking process, personality, or environment could be connected with some creative products it would be impossible to make a claim that it was a “creative” thinking process, personality, or environment. It can be argued, therefore, that assessing creativity by judging the creativity of actual creative products is the most basic, and most essential, kind of creativity assessment.

The Consensual Assessment Technique

In 1982 Teresa Amabile published a paper describing the Consensual Assessment Technique, which is the primary method used by psychologists today to assess the creativity of products of all kinds. The key idea is simple: experts in a given domain are the people who best understand and are in the best position to assess the creativity of products in that domain. When Nobel Prizes, Fields Medals, or Academy Awards decisions are made, they are not made by either polling a random sample of people or asking creativity experts to develop creativity-assessment rubrics. Similarly, when using the Consensual Assessment Technique, experts in the domain in question are asked to judge the creativity of products in that domain. Collages, poems, and stories have been the most widely used in psychological studies (in part because almost anyone can create such artifacts, whereas most people would come up empty if asked to do things like compose a musical score, create a computer app, or develop a cosmological theory), but in principle the Consensual Assessment Technique could be used to assess the creativity of any kind of product or artifact (including both things that have taken years to create, such as a novel, and spontaneous things, like a joke; Kaufman et al., 2008; Luria et al., 2018).

Consensual Assessment Technique judgments can use a Likert-type scale or they can rank-order the items being judged. In all cases, all of the expert judges assess the creativity of the same pool of items, and the judges work independently in making their assessments. (In general, the experts do not even know who the other experts are, and in no case should they have any opportunity to confer with one another until after all assessments have been made.) When experts (typically 5–15) independently make such creativity assessments, inter-rater reliability is typically quite high, usually 0.80 or higher, as measured by coefficient alpha. And when different groups of expert judges assess the creativity of different creative products of the same kind (e.g., two or more poems, two or more stories, or two or more collages) produced by the same person, the results evidence considerable consistency, even over time.

But one might very reasonably ask, “Don’t expert judgments of what is creative change over time?” They do, of course, although probably much more so in the case of cutting-edge, paradigm-shifting, genius-level creative products than in the garden-variety creativity of subjects in most research studies. But even if they do change over time, what the Consensual Assessment Technique provides is the best possible assessment at a given point in time, an assessment that might be different in a different century but that is unlikely to be much different in a year or even a decade.

There has been some controversy regarding what constitutes expertise and even if expertise is needed when using the Consensual Assessment Technique. Experts are far fewer in number, and much more expensive to use, than novices (often undergraduates, who are both plentiful and cheaply hired), but research has shown that in most cases actual experts in the domain are indeed needed. Novice judges often do agree with one another (in the sense that, with a large enough group of novice judges, it is possible to get acceptable levels of inter-rater reliability), but although they agree with one another, the judgments of novices often are at odds with those of experts in the domain. There are times when what one might want is a poll of non-expert opinion (such as People's Choice Awards) rather than expert opinion, but not, generally, if one's goal is assessing creativity. For this reason, the validity of any non-expert judgments can only be assumed if it has been demonstrated in a given domain (and for a specific task in that domain) that the creativity ratings given by novices of a certain type (e.g., quasi-experts who have considerable familiarity in a domain but not clearly recognizable expertise) closely match those given by experts in that domain. Simple inter-rater reliability can provide evidence of validity only with the use of experts in a domain — or with judges whose creativity ratings have been demonstrated to match those of such experts (Baer et al., 2009; Kaufman et al., 2009; Kaufman et al., 2008; Kaufman et al., 2013).

The need for the domain experts to judge the same set of products puts some limits on ways the Consensual Assessment Technique can be used. It is not possible to standardize such assessments, at least not in any reasonably cost-effective way. A given groups of items being judged could, as a group, be more or less creative than a different group of items of the same type. If, for example, one group of collages had been created by a group of middle school students and another group of collages by elementary school students, the collages in the former group would tend to be more creative, on average, than those in the latter group (Baer, 1993, 1996). If a collage were included in the former (more skilled) group it would receive lower creativity ratings than if it had been included in that latter (less skilled) group because all comparisons are relative to the specific group of products being judged.

This limitation can be partially offset by using groups of similar participants. If, for example, one had 1,000 short stories written by high school students to judge for creativity, it would be difficult to have a single set of expert judges rate each of the stories in comparison to the all of the other 999 stories in the sample. (Not only would it be difficult to keep such a large set in mind, which might result in shifting standards as experts worked through the set of stories. Simply finding experts willing to take on such a task would likely be problematic!) But if one divided the 1,000 stories randomly into 20 sets of 50 stories each and then had groups of experts rate the creativity of the stories in each set in comparison to the other stories in that set, scores obtained on stories in each set might fairly safely be compared. The experts who rate each set of papers might be entirely different, or there could be overlap. What is important is that the stories be rated for creativity in comparison with the other stories *in that set* and that the full range of possible scores be used in the ratings. Judges need to be coached to give roughly the same number of ratings at each level — this is to avoid rating nearly all the papers at the same level, which would provide very little discriminatory power — and to use more than a small number of levels. If just a two-level (high or low) or three-level (high, average, or low) scale is employed, differences in creativity may be obscured. Five or more levels — or at the extreme, a rank ordering of the entire set of products — provides greater discrimination.

In judging assessment methods, psychologists look for both validity (Is the test measuring what it is supposed to be measuring?) and reliability (Are the results of the assessment consistent?). Both are necessary; having one without the other is no better than having neither. For example, a test that gives consistent results but that is measuring something other than what it says it is measuring (such as a test of knowledge of history that is really only measuring reading comprehension; a clock that is broken and always gave the same time; or a test of creativity that is actually measuring extroversion or self esteem) would be worthless. Similarly, measurements that are erratic (such as an exam that different readers give widely varying scores; a ruler made of an elastic material that expands and contracts depending on the temperature; or a creativity test that produces widely varying scores depending on which version of the same test one used) would be of little use. (In fact, both kinds of tests could be worse than having no test at all, because users of the tests would believe, based on test scores, that they know something that in fact they do not know.)

Creativity assessment has been hampered by the need for both reliability and validity. Other types of assessments based on things like personality profiles, tests of thinking skills of various kinds, and self-assessments of creativity always need to come back, in some way, to validation via actual creative performance. This is an important advantage of the Consensual Assessment Technique, which is rooted in creative performance. The validity of Consensual Assessment Technique assessments is underwritten by the knowledgeable judgments of the experts in the domain in question. (If one is going to judge the creativity of, say, a painting, one would use recognized experts in the field — such as painters, art critics, art teachers — as judges. What could possibly supersede their combined judgment of the creativity of a group of paintings?) The reliability of Consensual Assessment Technique assessments is measured by the degree to which the ratings of experts, working independently, agree with one another. No other method for assessing creativity has such built-in validity and easy-to-measure reliability.

The Consensual Assessment Technique does have one major drawback: it is very resource-intensive. Unlike a quick self-assessment or skills test, participants must first actually create something. Then experts in whatever domain the assessment is taking place must be employed to examine and judge each of the things the participants have created, one by one and in comparison with all the other creations in the group, which typically means examining each creative product multiple times. The Consensual Assessment Technique has been deemed the “gold standard” of creativity assessment because of its validity and reliability, but perhaps the term might also apply to its expense (in terms of both time needed to use the technique and money needed to compensate expert judges), which can be considerable.

Applications of the Consensual Assessment Technique

The Consensual Assessment Technique has been widely used in creativity research. Pioneered by Refs. [Amabile \(1982, 1983\)](#) for research in the social psychology of creativity (with a focus on intrinsic motivation), it has since been used in creativity research of all kinds. It has been especially useful in looking at the question of the degree to which creativity is domain specific (i.e., are creative thinking skills, creative work habits, creative personalities, etc. the same, or even similar, across domains, or do they vary by domain?). Amabile originally used the Consensual Assessment Technique as a general measure of creativity, under the assumption that the domain she happened to choose was not a significant variable. She used primarily story-writing, story-telling, poetry-writing, and collage-making as her tasks because these were tasks that almost all potential research participants could complete. The Consensual Assessment Technique does not assume either domain specificity or domain generality, however, so unlike other kinds of creativity assessments (which almost uniformly assume domain generality), the Consensual Assessment Technique provides an assumption-free method of creativity assessment that is ideal for such comparisons.

The Consensual Assessment Technique is also used for admission to special programs, such as creative writing, science, and engineering programs, and for awards programs ([Baer and McKool, 2009, 2014](#)). In many ways the Consensual Assessment Technique is simply a formalization of ways to assess creativity that have long been used in educational and award contexts. Asking experts in a domain to assess the creativity of things applicants or candidates have created long predated the 1982 birth of the Consensual Assessment Technique. The formalization of this process through Consensual Assessment Technique procedures has made it possible to measure the reliability of these procedures and to document the conditions under which they are valid.

The Creative Achievement Questionnaire

One can assess the creativity of discrete products (using the Consensual Assessment Technique or less formal procedures, such as those used in many competitions or admissions decisions that stress creativity), but one might also be interested in long-term creative productivity. One procedure that has shown evidence of validity in making such assessments is the Creative Achievement Questionnaire.

Development of the Creative Achievement Questionnaire followed five key principles:

1. Creative achievement is best assessed in a domain-specific manner. Achievement in one area of creative endeavor (painting, architecture, or scientific discovery) does not necessarily imply creative excellence in all areas. However, many individuals boast accomplishments in more than one domain of endeavor. The CAQ was therefore designed to identify specific domains of achievement as well as to provide an indicator of total accomplishment across multiple domains.
2. Creative achievement implies exposure to, and acquisition of knowledge and skill in, the appropriate domain of endeavor. The CAQ was therefore designed to provide an indicator of training in domains of creative accomplishment.
3. Recognition by experts in the domain is the most valid and practical criterion for judgment of accomplishment. The CAQ was therefore based upon public acclaim ranked by field “experts.”
4. Recognition of an achievement by a broad range of experts rather than a narrow range implies greater accomplishment. The CAQ was therefore designed to give more weight to national than to local awards and acclaim.
5. Fewer individuals attain higher levels of achievement. The CAQ was therefore designed so that the levels of achievement acknowledged by the fewest individuals received the most weight. ([Carson et al., 2005](#), p. 39, p. 39)

The Creative Achievement Questionnaire is an indirect measure of creative products in a wide variety of domains. It asks respondents about specific, notable, and public accomplishments in each of those domains. The domains assessed using the Creative Achievement Questionnaire are visual arts, music, dance, creative writing, architectural design, humor, theater and film, culinary arts, inventions, and scientific inquiry. Validation of the Creative Achievement Questionnaire has included assessments of the creativity of actual creative products using the Consensual Assessment Technique.

In some ways the Creative Achievement Questionnaire is a self-assessment, and creativity researchers have many reasons to distrust creativity self-assessments. The Creative Achievement Questionnaire avoids that weakness better than most self-report scales by asking about specific kinds of accomplishments, such as (in the visual art domain) “My work has won a prize or prizes at a juried art show” or (in the writing domain) “My work has been reviewed in national publications” ([Carson et al., 2003](#), p. 500). There is still substantial room for subjective judgments, however, which may result in considerable error. For example, one “Scientific Discovery” question asks how many research grants the participant have been awarded. Some respondents might include small internal seed grants or travel grants, whereas others might assume this refers only to major federal funding grants. The scales used in many do not specify or in any way account for significant gradations of awards, conflating local, regional, and national awards as well as awards by groups with highly different standards (including, perhaps, pay-to-play publications and conferences in which anyone can have their work accepted).

One review also noted a problem the authors termed “implausible values”:

In theory, the CAQ’s items function as stair steps: people shouldn’t endorse the high-achievement items without also endorsing the preceding items. For example, no one should endorse “I have been paid to act in theater or film” without having endorsed the earlier item “I have performed in theater or film.” But some participants have aberrant response patterns, such as endorsement of only a single high value or endorsement of illogical patterns of accomplishments. It isn’t clear what to do with such response

patterns, and the literature on the CAQ to date has not discussed it. (Only a small percentage of a sample will have unusual patterns, but this subgroup can have a large influence simply because they are part of the minority that didn't get a score of 0 or 1.) (Silvia et al., 2012, p. 21, p. 21).

Because the Creative Achievement Questionnaire focuses on significant, observable accomplishments, most people will score low, producing strongly skewed scores with most people piled up at the low end of the distribution; only people who have made significant achievements in at least one domain can possibly receive high or even modest scores on the Creative Achievement Questionnaire. The Creative Achievement Questionnaire is therefore only useful for making discriminations among people who have made significant accomplishments of some sort; in fact, most people receive scores of zero in all ten domains. There is virtually no discrimination possible among participants, such as elementary school children, who have had limited opportunity to make notable creative achievements.

The Creative Achievement Questionnaire provides creative achievement scores for each of the domains it measures. Although some factor analytic work has been done, it is not clear how or if these ten scores can or should be reduced. Silvia et al. (2012) noted that "the factor analytic evidence for the CAQ is still preliminary. Neither of Carson et al.'s factor solutions included all 10 domains, and the analyses did not seem to take steps to accommodate the serious skew in the scores. Additional research (particularly work involving confirmatory models) is needed" (p. 22). For research in which participants can be expected to have made fairly significant accomplishments in one or more domains, however, the Creative Achievement Questionnaire is both much simpler to use than the Consensual Assessment Technique and is a measure of lifetime creative achievement, not creative achievement on a single task such as writing a poem or creating a collage. For most research studies with participants who have not (yet) made significant creative achievements in any domain, however, the Consensual Assessment Technique is the better choice.

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Measurement: Self-Report Creativity

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Introduction

Over the past several decades, researchers and practitioners have shown a growing interest in the assessment of creativity, developing a number of different approaches to measuring it. These approaches include attitude and interest inventories, biographical inventories, divergent thinking tests, environmental climate inventories, judgement of products, personality inventories, ratings of eminence, ratings by peers, teachers, or supervisors, and self-reports of creative activities. Many of these measurement approaches utilize self-reports (i.e., attitude and interest inventories, biographical inventories, personality inventories, self-reports of creative activities). Creativity self-report measures can assess the extent to which an individual perceives themselves to hold the personality traits or cognitive processing abilities to produce a creative product. Creativity self-report measures can also assess an individual's engagement in creative activities. Commonly used for their convenience and feasibility, creativity self-report measures have been used as a predictor of creative performance, creative achievement, creative effort, and creative potential, as well as a criterion for creativity.

Types of Self-Report Creativity Measures

Creativity is often defined as the production of an idea, artifact, or behavior that is considered both novel and appropriate. The definition of creativity involves four aspects: person (what characteristics make up a creative individual), product (what is considered creative), press (what contextual factors facilitate or inhibit creativity), and process (what is the procedure to arriving at a creative product). Indeed, creativity is a multifaceted and complex construct, which results in multiple and differing approaches to measurement, even in the context of self-reports.

Creativity researchers proposed several different taxonomies for creativity self-report measures. For example, [Batey and Hughes \(2017\)](#) classified self-reports into measures of either product, process, or trait. They proposed that products measure creative achievement, or the extent to which a person has creative accomplishments in a variety of domains. Process measures ideational behavior, or the extent to which a person believes they exhibit creative behaviors. Traits measure constructs such as creative self-efficacy (the extent to which a person believes they are creative), self-rated creativity (the extent to which a person considers themselves to be creative), creative personality (the extent to which a person believes they hold creative personality traits), and creative personal identity (the extent to which a person characterizes themselves as creative). These three aspects of self-report creativity correspond to three of the suggested four Ps in Rhodes's taxonomy, leaving out only creative press.

[Kaufman \(2019\)](#) took a different taxonomical approach, classifying self-report creativity measures into activities, process, beliefs, and evaluation. Activities measure a person's participation or achievement in creative activities. Process measures the extent to which a person assesses their creative processes. Beliefs measure the extent to which a person thinks about creativity, as well as their own creativity. Finally, evaluation measures the extent to which a person assesses their creative work in domain-general and domain-specific areas. The following subsections discuss the different types of creativity self-report measures using Kaufman's taxonomic approach.

Activities

Activity self-report measures ask individuals to report their creative achievements or engagement in creative activities. These types of measures range from assessing creativity at the everyday level to the eminent level, and assess either domain-specific creativity, domain-general creativity, or both. When reporting creative activity, participants can misinterpret engagement or achievement.

However, compared to other types of self-report creativity measures, reports of creative activities and accomplishments are argued to be less vulnerable to inflation and social desirability. Thus, this type of self-report measure is argued to be a more appropriate proxy for creative performance. Highlighted below are several self-report measures that assess creative activity.

[Holland \(1961\)](#) developed a 16-item checklist of scientific and artistic accomplishments assumed to require creative behavior (i.e., “invented a patentable device”; “won literary award or prize for creative writing”). Holland’s approach to assessing creative performance specifically involved asking individuals about public recognition in science and the arts (i.e., awards, prizes, publication). Holland’s checklist approach and recognition of domain specificity helped shape development of future activity self-reports (e.g., [Hocevar, 1979](#); [Milgram and Milgram, 1976](#)).

[Milgram and Milgram \(1976\)](#) developed an activity self-report measure, asking individuals to report on a variety of items describing accomplishments across nine domains: community service, dance, drama, fine arts, music, science, social leadership, sports, and writing. These items were presented to individuals in order from low quality accomplishments to high quality accomplishments in each domain. In addition to being more specified in terms of domains compared to [Holland \(1961\)](#), Milgram and Milgram’s measure also differed in scoring. Whereas frequencies are calculated for [Holland \(1961\)](#)’s measure, [Milgram and Milgram \(1976\)](#)’s measure can produce three scores: (1) a score for each *domain* an individual was involved in, (2) a score for each *activity* an individual was involved in, and (3) a weighted score dependent on sample responses that gave an individual a lower score for engaging in common activities and a higher score for engaging in rare activities.

[Hocevar \(1979\)](#)’s Creative Behavior Inventory (CBI) is another activity self-report measure similar to [Holland \(1961\)](#). The CBI asks individuals to report the extent to which they engage in 90 creative activities and accomplishments that range from everyday creativity (i.e., “made your own holiday decorations” and “designed a game”) to professional creativity (“entered a mathematical paper or project into contest” and “received an award for a performance in a popular dance”). The inventory covers a total of six domains: fine arts, crafts, literature, math and science, music, and performing arts. Additionally, there are 15 miscellaneous items that do not fit into a particular domain. In completing the inventory, participants are given the choice to respond “never”, “once or twice”, “3–5 times”, and “more than 5 times” to each item. Thus, unlike [Holland \(1961\)](#), the CBI asks individuals to report on a greater number of activities and accomplishments, and these activities and accomplishments are specified even further in terms of domain. Additionally, whereas [Holland \(1961\)](#) asks individuals to simply check the items that apply to them, [Hocevar \(1979\)](#) asks individuals to report on a scale ranging in engagement frequency (i.e., 3–5 times). For a shortened version of the CBI, see [Dollinger \(2003\)](#), who shortened the CBI scale to 28-items by removing items that asked about infrequent, high-level accomplishments.

[Batey \(2007\)](#)’s Biographical Inventory of Creative Behaviors (BICB) is another activity self-report measure. Unlike the previously mentioned activity self-report measures, the BICB assesses creativity at a general level. More specifically, the BICB asks participants to indicate whether or not they engaged in 34 everyday creative activities over the past 12 months (i.e., “written a short story”, “produced your own food recipes”, “selected to lead/manage others”, “made up a joke”, and “formed a sculpture using any suitable materials”). Because there are no subscale calculations for the BICB and because the items are categorical, the binary scores are computed to obtain an overall creativity score.

The Creative Achievement Questionnaire (CAQ) created by [Carson et al. \(2005\)](#) is an activity self-report measure that assesses creativity at the professional level and eminent level. The CAQ asks individuals to report their creative accomplishments in ten domains: visual arts, music, dance, architectural design, creative writing, humor, invention, science, theater and film, and culinary arts. Individuals are presented each domain and asked to place a checkmark beside the sentences that apply to them. The list of sentences range from having no training or recognized talent in the given area to having been nationally recognized in the given area. The CAQ does not only provide domain-specific creativity scores, but can also be scored to compute a total creative achievement score. However, the CAQ focuses on more professional level activities as opposed to everyday creative activities. As such, it tends to result in skewed distributions and may not be appropriate for many samples.

More recently, [Hoffmann et al. 2016](#) constructed a self-report creative behavior scale that assesses engagement in digital creativity in adolescents. Known as the Creative Behavior Questionnaire: Digital (CBQD), this measure asks participants to report the extent to which they engaged in 30 activities over the past three months, last year, and in their life (i.e., “created a podcast”, “made a music mash-up”, and “started a new blog”). Participants respond on a scale ranging from “never” to “4 or more times”.

Most of the measures identified here ask participants to evaluate the frequency in which they engage in a specific creative activity. Several of these measures also ask participants for specific accomplishments in multiple domains. As a result, these measures tend to be viewed as somewhat more objective than other self-report measures. However, it is important to note that these measures may not be appropriate for measuring creativity under certain circumstances. For example, asking about engaging in creative activities and accomplishments in music, art, or science, is likely not going to be relevant to understanding or predicting who will be a creative leader.

Process

Although most measures that assess creative processes are in the form of a divergent thinking task or creative problem solving task, some researchers created self-report approaches. These process-oriented self-report measures assess aspects such as ideational behavior, creative cognitive processes, and creative thinking styles – universal aspects of creativity that can be assessed regardless of an individual’s level of creativity and regardless of the creative domain. One challenge with process self-report measures is

that it may be difficult to assess cognitive processes that are automatic in nature. Additionally, of the four types of self-report measures, there are a limited number of process measures a researcher can choose from. Discussed below are three self-report measures that assess creative processes.

The Runco Ideation Behavior Scale (RIBS) developed by [Runco et al. \(2001\)](#) asks individuals to indicate the extent to which they exhibit appreciation of, use of, and skill of idea generation in their everyday life. The scale consists of 23 items that individuals respond to on a 5-point Likert-type scale ranging from “never” to “just about every day, sometimes more than once each day, etc.” Items include “sometimes I get so interested in a new idea that I forget about other things that I should be doing”, “I would take a college course which was based on original ideas”, and “I am good at combining ideas in ways that others have not tried.” More recently, the RIBS has been revised to include a 74-item long form (RIBS-V) and a 19-item short form (RIBS-S).

[Zhang and Bartol \(2010\)](#) also developed a self-report measure to assess creative processes. Known as the Creative Process Engagement scale, this measure asks individuals to indicate the extent to which they engage in problem identification, information searching and encoding, and idea generation. Items include “I decompose a difficult problem/assignment into parts to obtain greater understanding” (problem identification), “I retain large amounts of detailed information in my area of expertise for future use” (information searching and encoding), and “I generate a significant number of alternatives to the same problem before I choose the final solution” (idea generation). Individuals are asked to respond to these 11 items on a 5-point Likert-type scale ranging from “never” to “very frequently”.

The Innovative Work Behaviors (IWB) scale developed by [De Jong and Den Hartog \(2010\)](#) includes four processes that are of particular importance for creativity and innovation in the workplace. Specifically, the scale includes a subscale for idea generation (generates original solutions to work problems), idea exploration (pays attention to issues that are not part of his/her daily work), idea championing (convinces people to support innovative ideas), and idea implementation (contributes to the implementation of new ideas). This measure focuses not only on the idea generation aspect, but also idea implementation.

None of these measures fully cover the entire cycle of processes. The RIBS measure focuses exclusively on idea generation. The Creative Process Engagement scale covers the first three phases, but stops at idea generation. In contrast, the IWB starts with idea generation and then covers processes important for implementation, which are crucial for organizational innovation.

Beliefs

The beliefs category consists of measures that ask individuals to report on their values, motivations, and personality traits as they relate to creativity. Belief self-reports are more focused on the creative person, generally assessing domain-general creativity instead of domain-specific creativity. Unlike the other three types of self-report measures, belief self-reports encompass higher-order constructs (e.g., openness to experience). Although belief self-reports are typically used as predictor measures of creativity, they have also been used as a criterion, positing that individuals are aware of the subtleties of their creativity. Highlighted below are self-report measures that assess creative beliefs.

The Self-Assessment of Creativity Scale developed by [Kaufman and Baer \(2004\)](#) is a self-report creativity measure that taps into individuals’ beliefs. This measure asks individuals to indicate the extent to which they believe they are creative on items such as “I am good at coming up with new and different ideas” and “I consider myself to be very creative”.

Researchers commonly use the [Tierney and Farmer \(2002\)](#) Creative Self-Efficacy Scale to assess an individual’s belief in whether they are able to produce something creative (i.e., “I feel that I am good at generating novel ideas”). [Karwowski et al. \(2012\)](#) developed the Short Scale of Creative Self (SSCS), an 11-item, Likert-type scale that assesses creative self-efficacy using six items (i.e., “I am good at proposing original solutions to problems”) and creative personal identity using five items (i.e., “my creativity is important to who I am”).

Researchers also measure individual motivation as it relates to creativity. For example, the Creative Mindset Scale developed by [Karwowski \(2014\)](#) assesses an individual’s beliefs as to whether creative ability is fixed or malleable. The scale is composed of 10 items, five items that measure fixedness beliefs (i.e., “you either are creative or you are not – even trying very hard you cannot change much”) and five items that measure malleability beliefs (i.e., “practice makes perfect – perseverance and trying hard are the best ways to develop and expand one’s capabilities”).

It should be noted that while these measures evaluate creative self-beliefs, they are somewhat distinct in nature. As noted, these measures can be viewed as precursors or predictors of creativity, but have occasionally served as the construct of interest.

Evaluation

Scales that fall under the evaluation category are those that ask individuals to appraise their creativity against a normative standard. Evaluation self-report measures can ask individuals to evaluate their creativity overall or in a specific domain. Because evaluation self-report measures assess either domain-general or domain-specific creativity, the normative group seems to matter (e.g., when asked about creativity in the arts, rating yourself against artists vs. rating against the general population). This feature of evaluative self-reports accordingly highlights the importance of individuals being aware of their creative performance in comparison to others. Discussed below are self-report measures that assess creative evaluations.

Some creativity researchers have asked individuals to estimate their perceived overall creative ability on a bell curve, an adaptation of [Furnham and Gasson \(1998\)](#)’s self-report intelligence measure. To illustrate, individuals are presented with a depiction of

a bell curve illustrating a normal distribution of creativity scores. Individuals are informed that a mean score of 100 indicates average creativity, 70 indicates below-average creativity, and 130 indicates above-average creativity. Individuals are specifically asked to rate their creative ability using this information presented.

The Kaufman Domains of Creativity Scale (K-DOCS) (2012) is another scale that asks individuals to evaluate their creativity in a variety of domains. This scale is based on items from other previously developed scales such as Carson et al. (2005)'s CAQ and previous shorter iterations. More specifically, the K-DOCS instructs individuals to report how creative they are in 50 different creative acts compared to people that are around the test taker's age and level of life experience. Domains include artistic (i.e., "appreciating a beautiful painting"), mechanical/scientific (i.e., "taking apart machines and figuring out how they work"), music and writing performance (i.e., "learning how to play a musical instrument"), scholarly (i.e., "gathering the best possible assortment of articles or papers to support a specific point of view"), and self/everyday (i.e., "planning a trip or event with friends that meets everyone's needs"). Individuals rate themselves on a 5-point Likert-type scale ranging from "much less creative" to "much more creative".

Domain General Versus Domain Specific Measures

Creativity self-reports are particularly unique compared to other measures because their structure can assume either domain-general or domain-specificity. As mentioned, some self-report measures tend to be domain specific, focusing on measuring creativity in specific domains (e.g., K-DOCS). Other self-report measures tend to be domain general, such as measures of creative self-efficacy or bell curve. There are also self-report measures that evaluate specific domains, but also provide an overall score that is across multiple domains, such as the CAQ.

The debate as to whether creativity is domain-general or domain-specific further complicates creativity measurement. In other words, if an individual is creative in science, are they also creative in writing or art? Are "creative people" creative in general or in a specific domain? Take Walt Disney for example. Walt Disney has been deemed one of the most creative individuals of all time. Is Walt Disney creative in the field of entertainment alone or do people consider Walt Disney to be a creative person in general? Would Walt Disney have been able to execute the same level of creativity in other fields, such as science or sports?

Early creativity measures were typically crafted under the assumption that creativity was domain-general (e.g., divergent thinking tasks). However, over time, the domain-general assumption abated as evidence of domain-specificity emerged. Particularly with self-reports, researchers began finding that individuals tended to self-report different levels of creativity depending on the domain presented. That is, individuals believe they are more or less creative in some domains over others.

Strengths and Drawbacks of Creativity Self-Reports

As with any measure, there are strengths and drawbacks to self-report creativity. Self-report creativity measures are beneficial in that they are highly feasible and practical to use. Self-report creativity measures are typically free of charge, quick to administer, and easy to score. With the exception of some activity self-reports (e.g., CAQ, BICB), self-report creativity scales also yield high reliability. What is more, self-report creativity measures have face validity, which is an important feature for the practitioner sphere. Creativity self-reports have also demonstrated significant positive relationships with other creativity self-reports, divergent thinking measures, and scores on the Torrance Tests of Creative Thinking.

In comparison to other approaches to creativity measurement, self-reports have their strong points. For example, aside from internal biases, self-report measures do not introduce increased error in the form of outside raters compared to other measurement approaches (e.g., scoring divergent thinking tests, judgement of products, other-ratings). Additionally, self-reports can assess creativity at both the domain-general and/or domain-specific level, whereas other measures may be indicative of only one level (e.g., domain-specific creativity assessed in judgement of products, domain-general creativity assessed in creative problem-solving tasks).

However, researchers do stress issues that come with using creativity self-reports. For example, due to the face validity of self-report creativity measures, individuals may be cognizant of what is being asked of them, which can potentially bias results (e.g., individuals may feel inclined to respond in a socially desirable way). In contrast, individuals may not be aware of their beliefs or self-concepts as they relate to creativity, thereby leading to understated or inflated results rather than the obtainment of true estimates. Additionally, self-report creativity measures are considered more appropriate for low-stakes situations (e.g., research) rather than high stakes situations (e.g., selection in work or school setting). It is important to note that in high stakes situations, measures of personality may be utilized to assess creativity, among other personality traits.

Indeed, compared to other creativity measurement approaches (e.g., divergent thinking tests, judgement of products, ratings by peers, teachers, or supervisors), some researchers caution against the use of self-report measures as a criterion, indicating that self-reports may focus more on motivation to be creative and creative self-efficacy, and are not directly related to actual creative performance. However, some researchers posit self-report creativity measures are acceptable to use as a criterion measure, arguing that individuals are most likely aware of their levels of creativity and can thus report on it accurately. Others argue that if a self-report creativity measure were to be used as a criterion, measures of creative achievement are optimal because they seem less susceptible to exaggerations and social desirability.

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Medicine

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Introduction

The relationship of medicine to creativity can be understood from historical and developmental perspectives. The current epistemological foundation of medicine is rational empiricism – an emphasis on phenomena that are measurable, quantitative and apprehended in a rational, analytical manner. Non-rational phenomena such as imagination, inspiration, and intuition – while important in the creative process – currently have an attenuated emphasis in medicine.

The emergence of rational empiricism in contemporary medicine can be traced historically. As discussed by Laurence Kirmayer (2006); 16th century Renaissance physicians such as Paracelsus placed imagination in a central role. According to Paracelsus all manifest phenomena - including those specific to medicine and healing - were understood as flowing from an act of creative imagination - an act that allowed trans-rational, celestial influences to impact upon the material world. But, foundational shifts occurred in medicine as western culture transitioned into the Enlightenment of the 17th and 18th centuries. Enlightenment thinkers were suspicious of any phenomena that could not be subjected to logic, reason and rational analysis. Non-rational phenomena such as the imagination were categorized a priori as irrational – without logic, reason and baseless – and imagination was rendered a groundless and illusory force. From the Enlightenment perspective the imagination became equated with the *imaginary* – the untrue, unreal and fanciful.

The countertrend to this diminishment of the imagination was represented by the emergence of Romanticism in the late 18th to mid-19th centuries. For the Romantics the non-rational force of the imagination surpassed conscious reason's ability to fully apprehend the depth of human experience. Ultimately, the tension between rationality and non-rationality contributed to a bifurcation between the arts and the sciences. In the sciences rational analysis and empirical proofs dominated, while in the arts non-rational phenomena such as imagination and inspiration were highly regarded and valued.

Western medicine developed in synchrony with these broader cultural trends and foundationally aligned itself with the sciences - adopting a singular focus on rationality. This alignment has endured. Over the past several decades it has been typified by the dominant position afforded evidence-based medicine (EBM). As stated by The Evidence-Based Medicine Working Group (1992) it: "de-emphasizes intuition, unsystematic clinical experience, and pathophysiological rationale as sufficient grounds for clinical decision making and stresses the examination of evidence from clinical research." EBM has made a substantial contribution by solidifying a rationally grounded scientific foundation for the practice of medicine. In addition, EBM is evolving - becoming more attuned to patient values, individual differences and clinical expertise. Yet the singular emphasis of EBM remains on rational processes, leaving it out of full alignment with the more complex processes that animate creative discovery. With regard to research, Desmond Sheridan and Desmond Julian noted the following:

Almost all research activity currently undertaken in support of EBM involves evaluations of existing evidence to determine the best available, usually in the form of systematic reviews, and this form of research has expanded greatly since the launch of EBM. This is quite different from original science, which seeks to explore and discover new knowledge (2016, p. 211).

In contrast to the singular, rational focus prominent in medicine, creativity is bimodal, and includes both rational and non-rational elements. The neuroscientists John Kounios and Mark Beeman (2015) provided support for this perspective by defining two distinct but interdependent modes operative in the creative process – a conscious, rational, *analytical* mode and an unconscious, non-rational, *insightful* mode. Kounios and Beeman described the analytical mode as one where solutions are arrived at in a rational

step-by-step manner. In contrast, the insightful mode is non-rational and is characterized by less linearity – a mode where solutions seem to appear spontaneously in a flash of insight. Their research provided evidence for the distinct neurophysiological features of these two modes of expression, and the ways they beneficially complement each other in the creative process.

The relative absence of an epistemology and methodology that includes non-rational processes served as an obstacle to the full development of creativity in medicine. [Roberta Ness \(2015a\)](#) – a leading creativity and medicine scholar – goes so far as to call the current situation a creativity crisis. While not primarily focused on historical and developmental factors, Ness has taken an unflinching approach to challenging the ways current individual, cultural, and institutional factors create an unfavorable balance away from creative innovation – and an attenuation of the creative dynamism needed for discovery.

In medicine the rational-empirical approach has the lasting advantage of emphasizing a rigorous, analytical methodology that guards against unsupported conceptualizations of disease processes and treatment strategies. But, the singular emphasis on rationality and the diminished appreciation for non-rational phenomena – such as intuition and imagination – simultaneously limits full engagement with the creative process. Notwithstanding this, the search for more effective ways to treat human affliction is a driving force and vitalizing element in the field of medicine, and creativity is fundamental to this endeavor. This article will discuss the creative process in medicine – both in the realm of the medical scientist and in the realm of the medical practitioner – with an eye to future developments that have the potential to increase creative capacity within the field.

Discovery - The Medical Scientist

The quest of the medical scientist is to discover new and better ways to treat disease and reduce human suffering. To support the process of medical discovery, a significant allocation of resources – both human and capital – is dedicated to this quest. Research America estimates that in 2017, in the United States alone, over 170 billion dollars were spent on medical and health research occupying 120,000 medical scientists.

[Morton Meyers \(2007\)](#) questioned whether this massive research enterprise is as rational and systematic as commonly assumed. Meyers chronicled a large number of significant medical discoveries and demonstrated that many were not made by painstaking experimentation, but rather by chance, or even by error. Confronting the notion that a singularly rational and empirical approach is the key to discovery, Meyers stated: “Rational thought can be applied only to what is known. All new ideas are generated with an irrational element in that there is no way to predict them” (2007, p. 6).

The example of Otto Loewi serves to illustrate the influence of non-rational phenomena in the creative process. Loewi discovered that communication between nerve cells was a chemical process – a discovery that laid the foundation for modern psychopharmacology. As an acknowledgment of the importance of this discovery, Loewi was awarded the Nobel Prize in physiology and medicine in 1936.

The inspiration that guided Loewi’s Nobel experiment came in 1920, in a dream – actually two dreams – as recounted by Loewi:

The night before Easter Sunday of that year I awoke, turned on the light, and jotted down a few notes on a tiny slip of paper. Then I fell asleep again. It occurred to me at six o’clock in the morning that during the night I had written down something most important, but I was unable to decipher the scrawl. The next night at three o’clock, the idea returned. It was the design of an experiment to determine whether or not the hypothesis of chemical transmission that I had uttered seventeen years ago was correct. I got up immediately, went to the laboratory, and performed a simple experiment on a frog heart according to the nocturnal design. (1960, p. 17)

Otto Loewi’s experience is consistent with [Graham Wallas’ \(1926\)](#) classic four stage model of the creative process. In Wallas’ model rational and non-rational modes of experience oscillate through four major stages: In the *preparation* stage conscious rational efforts are applied to acquire knowledge. Next, in the *incubation* stage – non-rational, unconscious processes ensue – supporting the development of insight and inspiration. Then, in the *illumination* stage creative ideas and inspirations, formed in the incubation stage, spontaneously emerge into consciousness. Lastly, in the *verification* stage conscious rational processes are re-engaged to evaluate the products of the illumination stage.

Transformative discoveries seldom, if ever, emerge without substantial preparation. Otto Loewi’s inspired dreams occurred in 1920. But, his medical studies were initiated in 1891, specific training in laboratory pharmacology started in 1898, and he began theoretical discussions regarding chemical neurotransmission in 1903. Hence, the conscious, rational, knowledge accumulating stage – the preparation that preceding his inspired dreams – extended over several decades. The incubation stage of Loewi’s discovery is difficult to define. As an unconscious and non-rational process incubation is more challenging to understand and demarcate in time. Yet, the notion of a period of incubation prior to creative emergence has significant empirical support ([Sio and Ormerod, 2009](#)), and the phenomenon of *unconscious work* – an associative process occurring outside of conscious awareness – has the best evidence as an explanatory mechanism ([Gilhooly, 2016](#)). It can only be inferred that the incubation phase of Loewi’s creative process took place in parallel with his extended period of preparation. In contrast to the prolonged preparation and incubation stages, the dreams that accounted for Loewi’s illumination stage occurred abruptly on two successive nights. Subsequently, several more decades of experimentation followed in the verification stage, to rationally analyze and validate the original findings.

Healing - The Medical Practitioner

Creative processes are also relevant in the day to day encounters between medical practitioners and their patients – encounters that number almost one billion per year in the U.S. alone. When spontaneous inspiration emerges for the medical scientist it is usually followed by a prolonged period of experimentation and verification. In contrast, creativity in the realm of the medical practitioner often takes on a greater immediacy, a more constricted time frame, and sometimes an urgency. For example, a colleague specializing in internal medicine - practicing at a major medical center - described the following experience:

The call from the resident awakened me at about 6:30 a.m. - acute myocardial infarction he suggested - while providing the results of mostly supportive investigations. He seemed sure, yet something seemed off. I felt a sense of uncertainty, anxiety, dis-ease – I don't usually feel this way anymore. I arrived at the hospital, examined the patient and continued to feel strange – anxious, stressed, uncertain – something is wrong. A respected consulting cardiologist concurred with the resident – myocardial infarction. Arrangements were made for immediate transfer and cardiac catheterization. My feelings of uncertainty and anxiety continued – they were not welcome but somehow I just let them be. The transfer of the patient to the cardiology unit was unfolding quickly - my anxiety persisted. Spontaneously, I asked the unit nurse to add an urgent thyroid screening test to the patient's blood work. The impulse came like an unformed thought, or more like a feeling, or a cluster of sensations, like a finger tapping me on the shoulder – a subtle something letting itself be known to me.¹

The findings of the screening test subsequently confirmed an acute thyroid abnormality. This physician's spontaneous inspiration radically altered the course of treatment. It occasioned a revision of the diagnosis and an alteration of the treatment plan that may well have saved the patient's life.

The study of diagnostic reasoning in medicine has drawn upon cognitive psychology and aligned with a dual process model that posits two modes of cognition: An analytical system that is rational and relies upon conscious thought, and a non-analytical system that is non-rational and relies on unconscious processes. The functioning of the non-analytical system is thought to be supported by pre-existing implicit knowledge, enhanced by experience, and reliant upon automatic pattern recognition. However, the non-analytical system's reliance upon unconscious processes is thought to render it prone to bias and error. This has led to an advocacy for training interventions designed to increase rational, analytical capacities, as safeguards against the error proneness of non-analytical cognition (Croskerry, 2013). There is value in pursuing strategies to increase the capacity for rational thinking and meta-cognition – the higher order awareness of one's thinking process – in medical practice. But, in relation to creativity, there is also a need for a more comprehensive understanding of non-rational processes, and the way they may support insight and inspiration.

The practitioner in the above vignette was inspired to order a thyroid screening test after several anxious hours of uncertainty. From the dual process perspective, neither rational analysis nor non-analytical pattern recognition is sufficient to fully account for the phenomena described. Rather, the vignette is better understood from the perspective of Wallas' previously described model of the creative process: The practitioner in this vignette has a substantial preparatory foundation. She is trained, experienced, and functions at an expert level. When the case was presented she recognized an immediate unsettledness – an intuition. Phenomenologically, intuition is distinct from creativity but related - commonly presenting as a vague anticipatory perception that serves to guide idea generation (Petervari et al., 2016). The practitioner reports staying with the experience of unsettledness while it persisted for several hours - presumably supporting the non-rational work of unconscious incubation. Then, the inspiration to order the laboratory test abruptly emerged into consciousness. The abrupt emergence of the insight phenomenologically distinguishes it from analytical thinking which is slow and deliberate - whereas insight comes in a flash. Also the quality of the insight has the clear sense of newness – a fresh idea. This is distinct from pattern recognition - which is the application of old and established information superimposed on a current situation. Then, in a return to rational cognition, the diagnosis was subsequently verified by analysis of the laboratory test.

While the vignette is anecdotal, and the understanding offered conjectural, it phenomenologically aligns with established models of the creative process. This invites a more nuanced application of the dual process model - and further inquiry into the manifestations of creativity in medical practice. Focused inquiry into creativity in medicine is not common, but there has been some nascent interest in related areas. For instance, Oliva et al. (2016) studied the impact of *gut feelings* in the diagnostic process in general practitioners – intuitive sensibilities that provide information in a non-rational manner. The group of physicians they studied reported using intuitive feelings commonly and effectively in their day to day work with patients. The authors further suggested that the ability to integrate non-analytical processes into clinical decision-making – along with rational, analytical, evidence based practice – is characteristic of advanced learning.

In considering the potential contributions of creativity to the practice of medicine Paul Haidet (2007) provided the useful analogy of jazz improvisation. Fundamental to advanced jazz performance is the ability to creatively improvise – to simultaneously compose and perform – an integration of rational and non-rational processes (Beatty and Jung, 2018). A long process of learning musical language is required prior to developing the capacity for jazz improvisation. Similarly in medicine, many years of preparation are needed to acquire the foundational knowledge necessary for practice. But then physicians are also potentially tasked with developing improvisational skills – advanced skills that allow them to creatively apply themselves to the clinical encounter – to

¹This clinical vignette was used with the permission of Jillian Horton, M.D.

spontaneously improvise in a manner that is attuned to the patient, clinical situation, and context. Some practitioners develop such skills organically as they progress toward mastery, but the therapeutic impact of these skills is rarely a focus of serious study, and support for their development is uncommon.

Pre-rationality, Rationality, Arationality

The philosopher [Jean Gebser \(1983\)](#) has meticulously and extensively provided cultural and historical evidence for the evolution of western consciousness through discrete developmental stages. From Gebser's perspective, mental-rational consciousness is currently the most prevalent method of apprehending the world. It is a perspective reliant on a structure of consciousness with the capacity for analytical thinking – the ability to apply sequential logic, linear causality and critical cognition. It relies upon empirical methods for knowledge acquisition – it is *rational*. The emergence of this form of apprehension is evident in the shift to Enlightenment thinking in the 17th and 18th centuries. While Gebser acknowledged that contemporary people do not consistently function rationally he would posit that most are capable of drawing upon this capacity. Gebser also observed that while the mental-rational structure affords considerable benefits – such as the rational empirical approach that is the foundation for the scientific method – it also can become deficient. For instance, when the open inquiry of science constricts into scientism – the fundamentalist belief that rational and empirical knowledge is the only valid form of knowledge.

The notion of non-rationality is more complex as it is not a unitary concept. In Gebser's model the structures of consciousness that historically and developmentally precede the mental-rational structure can be considered *pre-rational* – they do not yet possess the capacity for rational cognition. Phenomena important in the creative process such as dreams, intuition and imagination are in this category. But, rather than rendering these modes irrelevant, Gebser proposed that their integration is fundamental to a new and emerging consciousness structure – a structure he labeled *integral*. The integral structure integrates all previous consciousness structures. It is also non-rational but is clearly distinct from pre-rational structures because it includes the mental rational structure. Gebser described this structure as *arational* – indicating a more comprehensive mode of awareness – an awareness that is informed by all previous consciousness structures. As such, the integral structure maintains the benefits of rationality, while seeing through the exclusivity of the rational perspective. In his analysis Gebser provided extensive examples of the emergence of this structure, as it is manifesting across diverse fields of human endeavor.

As it relates to creativity, Gebser's integrative phenomenological perspective is in accord with emerging evidence from the neurosciences. For example, the neuroscientists [Roger Beaty and Rex Jung \(2018\)](#) have studied creative cognition – with an emphasis on understanding the neural mechanisms underlying creativity in general – and artistic improvisation in particular. Their work focused on the relationship between the brain's default mode network and the brain's executive control network – two large-scale neural networks. The default mode is a network of mid-line and inferior parietal brain sites that are active when the brain is engaged in non-rational processes such as mind wandering, imagining and dreaming. In contrast, the executive control network, which includes the dorsolateral pre-frontal cortex as a core hub, is engaged during tasks requiring externally directed attention, and supports rational processes such as executive functions, cognitive control and conscious decision making. These two networks have been considered to have an anti-correlated relationship – engagement with one suppresses activity in the other. However, [Beaty and Jung \(2018\)](#) present evidence of coordinated activity between these two networks in creative activities such as improvisation – providing neurological support for the notion that integration of rational and non-rational processes is important in creative processes (see Neuroscience: The Cerebellum).

Operationalizing the preceding theoretical constructs, [Richard Szuster \(2018\)](#) has provided preliminary evidence demonstrating that deliberate efforts to integrate rational and non-rational elements can facilitate the creative process. In a naturalistic study using Embodied Imagination – a method of working with dreams and the imagination pioneered by [Robert Bosnak \(2007\)](#) – normal waking consciousness was activated concurrent with dream-like consciousness. After the intervention, study participants reported a re-enlivening of their creative processes and increases in their creative productivity. Additionally, an electroencephalograph was employed to investigate the neurophysiology present during the Embodied Imagination session. Analysis demonstrated a more integrated brainwave pattern in study participants during the session – where frequencies typical of normal waking were present in a more balanced relationship to frequencies typical of dreaming. These findings suggest that the increased creative productivity reported by study participants was associated with a measurable and replicable neurophysiological state – a state of mind that was evoked by the concurrent presence of rational and non-rational processes.

The net result of the aforementioned is the emerging notion that the creative process can be supported by a creative mind state – a mind state that is aligned with a developmental capacity for integration of rational and non-rational processes. Contributions from the neurosciences are beginning to provide further support for this perspective, suggesting that the capacity for this form of creativity – expressed at a phenomenological level – has distinct correlates at a neurological level.

The Creative Mind in Medicine

The frequently referenced touchstone – “chance favors the prepared mind” – was articulated by Louis Pasteur, the great French microbiologist and pioneer of the germ theory of disease. It suggests that flashes of insight, the foundation for creative discoveries, do not just happen, but are facilitated by preparation. In medicine, preparation emphasizes empirical knowledge – being fully informed of

the pre-existing scientific evidence base – a conscious, rational form of knowing. This form of preparation is necessary, valuable and fundamental in medicine but - as previously noted regarding the creative process - it is partial. What follows are examples of efforts to facilitate the creative process in medicine by expanding beyond an exclusive focus on rational, linear, analytic processes and implementing additional forms of preparation.

Unmasking Genius: Cognitive Tools to Enhance Creativity

Roberta Ness (2011, 2013) has been a leading advocate for the development of creative capacity within the medical sciences. Drawing upon effective creativity training programs in education and business - and her own research into the lives of highly creative individuals - she created the *Innovative Thinking* program for the health sciences. In this program Ness outlined a set of cognitive skills that can be taught and learned in the interest of increasing creative capacity. Included in the Innovative Thinking teaching curriculum are cognitive tools such as: broadening problems, narrowing perspectives, reversing assumptions, using analogy, and brainstorming - all taught with the goal of improving observational skills, facilitating creative inspiration, and supporting the generation of original ideas. Students completing the program demonstrated substantial increases in creative thinking, as measured on a standardized test of idea fluency and originality (Ness, 2015b).

A particular focus of Ness' program is developing the capacity to "think outside the box." This skill addresses the habitual tendency to be constrained by pre-existing mental constructs and patterns – patterns that Ness labels *frames*. Frames are static assumptions and expectations based upon past learning. While frames allow for the efficient application of pre-established knowledge, they restrict the understanding of new information – automatically accommodating new information to established perspectives that conform to pre-existing conceptualizations and mental structures.

Consider the 'frame-breaking' example of Robin Warren - who was awarded the Nobel Prize in Medicine in 2005: In 1979 the idea that stomach ulcers were a result of excess stomach acid was a well-established dogma in medicine – a pre-existing frame. A large body of clinical literature supported this notion and a system of treatment was built around this dogma. Some of the medications designed to reduce stomach acid eventually became the world's biggest selling prescription drugs. Into this environment Robin Warren, an unknown Australian pathologist, presented the audacious idea that stomach ulcers were caused by a bacterial infection, not excess stomach acid.

Robin Warren's discovery began on an ordinary afternoon in 1979 while working in the pathology laboratory of the Royal Perth Hospital. Warren was at his microscope routinely examining a gastric biopsy sample – a sample of stomach tissue routinely taken to confirm the diagnosis of a stomach ulcer. As expected, he noted the sample to have changes consistent with chronic gastritis – an inflammation of the lining of the stomach.

But, on that day in 1979, Warren thought he could discern a faint bluish line in the sample. The line drew his attention and piqued his curiosity. Higher magnification unexpectedly showed the line to be composed of bacilli, a rod shaped form of bacterium – a contradiction to another pre-existing frame - that bacteria could not exist in the acidic environment of the stomach. Warren wondered if bacterial growth might be important in the formation of stomach ulcers – a novel, provocative and frame-breaking idea. It took years of rejection, ridicule of the idea, and the association with an energetic young colleague named Barry Marshall, before Warren was found to be correct. This discovery eventually led to a radically altered understanding of the cause of stomach ulcers, a revolution in treatment, and a Nobel Prize in Medicine.

The process of Warren's discovery is consistent with the frame-breaking strategies emphasized in Roberta Ness' Innovative Thinking program. Warren's discovery depended upon a capacity for observation that was not constrained by the prevailing frame – a frame that had limited the perception of thousands of other pathologists – who had examined many thousands of samples similar to Warren's – but were unable to see what Warren saw.

Mindful Practice: Creative Mind – Beginners Mind

The Innovative Thinking program, described in the previous section, has a concentrated focus on developing cognitive skills and creative thought. This section describes *Mindful Practice*, a more broadly focused program that - while not specifically focused on creativity - is exemplary of the integrative phenomena that are fundamental to the creative process. The program was designed by Ronald Epstein and Michael Krasner (2017) and employs elements such as narrative medicine, appreciative inquiry and contemplative practices to support the development of exemplary practitioners. The Mindful Practice program has been associated with an increased capacity for mindfulness, enhanced physician wellbeing, and improved attitudes associated with patient-centered care (Krasner et al., 2009).

Mindful Practice employs processes that are known to enhance creative potential. For instance, open monitoring meditation – a practice in which an open, allowing, and nonjudgmental attitude is cultivated toward whatever phenomena are arising in awareness – has been shown to be associated with increased creativity (Baas et al., 2014). Open monitoring meditation facilitates an ability to be non-reactively present from moment to moment, while simultaneously maintaining a discriminating awareness. This form of meditation has also been shown to activate the brain's default mode network sites concurrently with the executive control network sites (Marzetti et al., 2014) – similar to Beaty and Jung (2018) findings with creative improvisation in the arts. As such, open monitoring meditation can be understood as an integrating practice – a creative practice – that concurrently activates brain networks responsible for rational and non-rational modes of experience.

Contemplative practices such as open monitoring meditation support the development of *beginner's mind*. Beginner's mind is a concept introduced to western audiences by the Zen Buddhist teacher [Shunryu Suzuki \(1987\)](#), and to medical practice by [Ronald Epstein \(1999\)](#). In Suzuki's words: "If your mind is empty, it is always ready for anything; it is open to everything. In beginner's mind there are many possibilities; in expert's mind there are few" (1987, p. 1). Beginner's mind is the cultivated naiveté of the expert – it possesses the capacity to remain open to new possibilities, a mind that can encounter phenomenon with a freshness that is not restricted by pre-existing mental concepts – it is inherently a creative mind (see Zen Meditation).

Fundamental to the development of beginner's mind – and also supported by contemplative practice – is an increased capacity for *presence*. Presence indicates an experience of being engaged with the present moment. Presence includes an increased capacity for perception directed toward the various experiential states that are arising in moment to moment experience. Presence is not a binary concept but a directional one, with greater or lesser degrees possible. The more present we are, the more our experience is palpable, concrete, vivid and exact. The more present we are, the more deeply we are in touch with and vivified by our experience. In accord with the previously discussed analogy of jazz offered by Paul Haidet, presence supports an attunement to the circumstances unfolding in the moment. It supports spontaneity – a greater capacity for creative improvisation in the unfolding immediacy of medical practice. Mindful presence also allows for more deeply engaged interactions with patients. [David Rakel \(2018\)](#) provided evidence for the beneficial impacts of empathic presence on biomedical treatment, suggesting that presence not only supports creative improvisation in the interaction between practitioner and patient, but also directly supports healing.

The practice of medicine is a multi-leveled and multi-dimensional undertaking. The manner in which creativity manifests in the midst of this complexity defies simple categorization. The Mindful Practice program employs strategies that are known to increase creative potential and have also been shown to effect a concurrent activation of the neural networks responsible for rational and non-rational processes. This supports the notion that Mindful Practice facilitates an integrative process that is fundamental to some forms of creativity. However, it is important to note that the creative impacts described in this section have been demonstrated in controlled laboratory settings. An understanding of the impacts in naturalistic settings – such as medical research and medical practice – requires investigation and represents an important, and only beginning, area of inquiry.

Conclusion

Creativity is important to the field of medicine, potentially adding vitality to both the pursuit of discovery and the practice of healing. The epistemological foundation for contemporary medicine is rational empiricism – a unimodal perspective that assures a rational, scientific approach to the acquisition of knowledge and guards against the assimilation of unproven conceptualizations and fanciful beliefs. However, creativity is a bimodal process that includes both rational and non-rational elements. A sole reliance on rational empiricism limits the inclusion of non-rational elements, such as intuition and imagination, and impedes a full engagement with the creative process. In medicine, the disunity between rationality and non-rationality cannot be resolved by suppression of either, but rather by integration of both. The emerging evidence presented in this article suggests that this integration has the potential to enable a creative state of mind, that maintains the benefits of rational empiricism, while providing a more optimal platform for scientific discovery and the practice of healing.

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Memory

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There are many ways to define memory. Memory can refer to the remembering of facts or bits of general knowledge (semantic memory) or the recollection of personal experiences (episodic memory). It can refer to a process that is largely conscious (explicit memory) or one that is largely unconscious (implicit memory) such as the influence of prior experience on thought and behavior. It can be measured over short or long periods of time, and it can reflect performance on anything from skilled motor tasks to the free recall of complicated text passages. The multifariousness of memory makes it difficult to discuss in the context of its relationship to creativity because different aspects of memory are likely to have very different effects on creativity (which itself is far from a unitary construct). The current entry will discuss a few of the many ways in which research has explored the intersection between memory and creativity.

Prior Knowledge and Mental Fixation

Novelty is a central property of creativity. To be creative something must be new or different from what came before. Most creative ideas, however, do not come out of thin air. Rather, they are built upon and in the context of existing knowledge and ideas. As Isaac Newton is often quoted if he has “seen further it is by standing on the shoulders of giants.” Information in semantic memory (accumulated general knowledge of facts, ideas, and concepts) provides an important foundation upon which to explore novel ideas and solutions. Domain expertise is critical for creative thinking, allowing people to develop novel ideas by flexibly integrating and extending upon already known ideas. It is not typical for creative contributions and innovations in art and science to occur, for example, without at least some prerequisite knowledge in the subject matter.

There are instances, however, in which having too much prior knowledge can impede creativity, such as when one needs to think in ways that differ fundamentally from what is already known or established. In such instances, creativity may require the generation of non-obvious ideas or solutions, and domain expertise and information in memory can serve as an impediment to creativity by causing a phenomenon known as mental fixation. Mental fixation, which has been studied extensively in research on creative cognition, can be defined as the limiting or constraining effect of existing knowledge or behaviors on the successful completion of some cognitive process, such as the ability to remember, solve problems, or generate new ideas.

As discussed in more detail below, prior knowledge about a topic often takes the form of a schema or gist-based representation. Although synthesizing information into schemas may speed processing and allow people to navigate their information-heavy world without getting slowed down by unnecessary details (and can in many instances benefit creativity), it can also oversimplify thinking and constrain thought. For example, people tend to think about how to use objects as they are intended (e.g., a hammer is for hammering nails, not breaking a window) because that is how they have been used in the past. Such functional fixedness makes it difficult to produce new uses for objects due to the accumulation of experience with those objects. A classic demonstration of functional fixedness comes from [Maier's \(1931\)](#) two-string problem. In this problem, the goal is to join two strings suspended from the ceiling at opposite ends of a room separated by more than an arm span's length. There are a few items available in the room including a pair of pliers. What is the solution? Tie the pliers to one of the strings and use its weight as a pendulum to help draw the string toward you while holding the other. Participants often fail to generate this solution, presumably because they are biased to think only of the pliers' more typical function.

The use of schematic knowledge representations allows people to fill in the details based on what they already know, but when trying to think of something new and creative they find themselves unable to do so. Indeed, when trying to generate new ideas, people tend to rely on a retrieval-based strategy in which they attempt to retrieve existing ideas. An example of this comes from the Alternate Uses Task (AUT) in which the goal is to generate unusual uses of common objects such as a car tire. There are many familiar and dominant functions associated with car tires (e.g., making vehicles move, using them as tire swings) and ready

access to these associations often confines thinking to these obvious ideas at the expense of trying more novel approaches (using the car tire to construct a chandelier). Much of this is a natural result of the structure of long-term memory. When given a cue in the form of a creative prompt, the information that comes to mind most readily tends to be the most frequent or obvious. It is often only later in the idea generation process that more original ideas begin to emerge.

People often rely on examples and prior knowledge without even realizing it. Indeed, explicit instructions to deviate from old and existing ideas in a creative generation task are often ineffective at reducing mental fixation, with participants continuing to rely on examples or existing knowledge stored in memory. In one study by Smith et al. (1993), for example, participants were asked to draw pictures of never-before-seen alien creatures. Participants exposed to examples of alien creatures were more likely to incorporate features of the examples (i.e., four legs, a tail, antennae) than participants not exposed to the examples. Critically, this effect emerged even if participants were explicitly instructed to draw new alien creatures that diverged as much as possible from the examples. Presumably, after integrating the example aliens with the problem space, participants were unable to branch away from them even when they had the intention to do so.

For better or worse, people use examples and old ideas in their creative generations. Although such reliance may be helpful in some instances by jumpstarting the creative process, it can also be detrimental when old ideas and examples are flawed or when the goal is to be as novel or divergent as possible. Moreover, domain expertise can exacerbate the situation when the solution to a given problem or the optimal to-be-generated idea does not come from that domain. In a study by Wiley (1998), for example, baseball experts and novices attempted to solve Remote Associate Test (RAT) problems. RAT problems involve presenting participants with three seemingly unrelated cue words (e.g., plate, broken, shot) and asking them to try to come up with a fourth word that is related to each of the three cue words (solution: glass). In this case, some of the problem words were baseball-related (plate), but the solutions were not. The baseball experts had more difficulty solving the problems than the novices, presumably because their knowledge of baseball-related information constrained their search space, thus making the generation of appropriate associates from memory more difficult.

Analogical Transfer

Existing knowledge can also play a role in creativity through the use of analogical transfer. Two situations are analogous when they share common underlying principles despite superficially being dissimilar. For example, compare the functioning of the cells of the body to factories. Although cells are superficially dissimilar from factories (e.g., factories are built out of bricks whereas cells are not), both share a set of abstract relations. In both systems, resources are brought in and processed by specialized units across separate stages in a regulated fashion to generate products. Indeed, much work on creativity has been dedicated to understanding how innovations in technology can be inspired by nature (i.e., biomimicry). Sometimes people can solve problems via analogy, with analogical transfer argued to occur when a person uses a known source situation to solve an analogous, but often dissimilar appearing, target problem.

Analogies have the potential to serve as powerful sources of insightful and creative solutions. To illustrate, consider a laboratory paradigm used to study analogical transfer (Gick and Holyoak, 1983). In the first phase, participants read a story about a general attempting to capture a fortress. The general has a large army, and several roads lead to the fortress from all directions. His army could march down any of the roads, but landmines would mean that the weight of his army would detonate the mines, destroying his army and the surrounding countryside. A smaller force would not detonate the mines but would also not be sufficient to capture the fortress. The general's solution is to divide his army into smaller groups positioned at the head of each road and send them marching toward the fortress at the same time. In this manner, the smaller forces do not detonate the mines, and they simultaneously converge upon the fortress which they overtake. In the second phase, participants encounter a problem involving a doctor attempting to treat a patient with an inoperable stomach tumor. There is a kind of ray that can destroy the tumor when of sufficiently high intensity. At this intensity, however, it would also destroy much of the healthy tissue surrounding the tumor. A lower intensity would spare the healthy tissue but fail to destroy the tumor. What might the doctor do? Participants can easily devise a solution if they notice the relevance of the convergence solution from the fortress story: deploy multiple low-intensity rays arranged around the patient and direct them simultaneously toward the tumor. In this manner, the low-intensity rays spare the healthy tissue as they pass through, but when they converge upon the tumor, their summed intensity is sufficient to destroy the tumor.

These two stories share a common, underlying solution structure despite their distinct contexts, and if people first encounter the fortress problem, they tend to be more likely to solve the ray problem. Interestingly, however, the solution rate is still rather low unless participants are given an explicit hint to think back to the fortress story. That is, even if participants sufficiently encode the information from the first phase of the experiment, they often fail to spontaneously realize the connection to the second phase of the experiment. This finding suggests that people do not readily use structural information (e.g., the similar divide-and-conquer strategies underlying each problem) during retrieval, but rather, that they tend to rely on surface-level information (e.g., a medical vs. a war scenario). A major goal in many creative problem-solving contexts is to get people to spontaneously notice the deeper, structure-level connections that enable clever solutions. To do this often requires shifting focus away from superficial details and toward more abstract, generalizable concepts. Memory retrieval is a highly limited and cue-dependent process, however, and the requirement to get away from the strongest or most pre-potent responses to the cues that are currently available can be a significant challenge. Said differently, what someone can retrieve at a given moment or on a given task is severely limited by the context and cues that are available—a limit that constrains not only memory but analogical transfer and creative thinking more generally.

Research has shown, however, that analogical transfer can be facilitated either when sources are encoded at a more abstract level (that will more easily generalize to new situations) or when people are led to think about the deeper structure of a problem while trying to solve it (see Analogies).

The Benefits of Forgetting

Many people lament that they have such a terrible memory because they forget so much of what they want to remember. The ability to forget, however, is an important and adaptive component of the memory system. Forgetting helps keep memory up to date by ensuring that old and outdated information does not interfere with the learning and accessibility of more current and relevant information. Beyond that, forgetting has been shown to facilitate the ability to think creatively (Ditta and Storm, 2018), such as in the case of incubation effects where taking a break after a failed problem-solving attempt (i.e., an incubation period) can make someone more likely to solve that problem during their second problem-solving attempt (Sio and Rudowicz, 2007). Various mechanisms have been argued to underlie the incubation effect. According to the forgetting-fixation hypothesis, taking a break allows for the forgetting of the information that caused fixation during the first problem-solving attempt. Presumably, when problem solvers make unsuccessful attempts at solving a problem, they increase the memory accessibility of fixating information that is unhelpful, thus blocking access to the target solution. Taking a break allows for the fixating information to be forgotten, thereby freeing the person to retrieve or generate the target solution (Smith, 1995).

It is important to emphasize that when memory researchers talk about forgetting they are typically not talking about a permanent loss of availability or storage strength, but rather a temporary loss in accessibility or retrieval strength. This distinction is critical both for the adaptive functioning of memory and in considering the role of forgetting in creativity. By making old and outdated information temporarily inaccessible, forgetting as a mechanism of reduced accessibility can mitigate mental fixation and allow people to think of new and creative solutions. By retaining the storage strength of forgotten information, however, such information can be recovered should it become relevant to solving a new problem or thinking of a new creative idea. In this way, forgetting as a loss of retrieval strength but not a loss of storage strength has the potential to benefit creativity both in the near and long-term.

Retrieval Inhibition and Executive Control

In the case of incubation effects, forgetting is thought to occur as the result of the passage of time or as the result of a change in context, reducing the heightened accessibility of whatever information was causing mental fixation and impeding performance. Research has suggested, however, that there may also be inhibitory mechanisms in memory that can help people overcome fixation. Attempting to generate target associates on the RAT, for example, has been shown to cause the forgetting of the non-target associates that initially impeded performance. Likewise, attempting to think of new uses for an object in the AUT has been shown to cause the forgetting of previously encountered and generated uses. Importantly, individuals who exhibit larger effects of forgetting in these and other contexts tend to outperform on tasks of creativity, suggesting that this type of inhibitory or goal-directed forgetting is not just a side-effect of creative thinking but that it may play an adaptive role in the process of creative thinking (Storm and Patel, 2014).

The idea that inhibition might be helpful for creativity may seem at odds with the popular belief that creative individuals tend to be uninhibited geniuses that are more prone to mental disorders and substance abuse. Indeed, research has also observed a positive relationship between disinhibition and creativity (Carson, 2014). In some studies, individuals with inhibitory deficits have outperformed individuals without such deficits and, in other studies, individuals without inhibitory deficits have performed better on a creativity task when their inhibitory abilities were temporarily reduced (e.g., by drinking cranberry vodkas). These kinds of benefits of disinhibition tend to be observed on tasks where it is advantageous not to be constrained or limited by common assumptions or the need to cohere to some set of rules or boundaries. A lack of inhibition may also be helpful in that it allows people's thoughts to drift away from the task at hand in the form of mind wandering. Mind wandering may benefit creativity by leading to a change in context or to a reduction in mental fixation that allows people to generate new ideas and make new connections in ways that they would not have been able to do otherwise. More generally, there is evidence that thinking of distantly-related analogies, or just doing something different, can facilitate creativity, presumably because it helps people overcome the limits of their current way of thinking.

Taken together, the finding that both inhibition and disinhibition can relate positively to creativity is consistent with the idea that the ability to flexibly engage executive control may be more related to creative thinking than either process alone. Indeed, recent neuroimaging work on the default mode network and the executive control network has shown increased co-activation of these networks in individuals who display high levels of creative thinking (Beaty et al., 2015). In the context of overcoming mental fixation, it may be useful to inhibit and forget the sources of fixation, a process that requires executive control. In other contexts, however, where one may want to be flexible in their thinking, it may be beneficial to consider everything, a process that would require a loosening of executive control. Indeed, the ability to take advantage of inhibition when it is helpful and then diminish it when it is not may be one of the hallmarks of a memory system that is designed to facilitate creativity.

It is also important to consider task dynamics when thinking about the role of inhibition and executive control in creative problem-solving. Take the case of insight problems, which are set up in such a way to cause problem-solvers to reach a point of

impasse by leading them to form an inappropriate initial representation of a problem (often caused by prior experience). Solving insight problems often requires people to shift or restructure the way they think about the problem. In matchstick problems, for example, the goal is to move a single match from an incorrect equation to make a correct equation, such as changing $XIII + I = XI$ to $XIII - I = XII$. Many people neglect to use the matchsticks in the “+” sign because they consider it to be an unbreakable unit, thus failing to produce the correct solution. Unlike analytical problems, which involve approaching the solution in incremental steps, insight problems involve generating the solution suddenly after a period of impasse. Whereas executive control may be useful for facilitating the formation of a problem representation and working through the initial search space, it may not be helpful for achieving the kind of spontaneous restructuring processes that are required to overcome impasse. Indeed, in some situations it may even serve as an impediment to restructuring, keeping the problem-solver locked in the state of impasse that they need to escape.

Collaborative Inhibition

When it comes to memory and creativity, working with others is not always the best option. In the context of memory, research has shown that when people work together to remember the same information, they tend to recall less than they would have recalled had they worked independently and pooled their outputs. This effect, known as collaborative inhibition, is thought to occur because each individual utilizes their own memory system and personal retrieval techniques to store and recall information, and listening to other people recall information in a group situation disrupts these processes (Rajaram and Pereira-Pasarin, 2010). Hearing others’ output may also result in fixation on that information at the expense of recalling more of the unrecalled information, a phenomenon similar to part-set cuing.

Similar mechanisms are at play when people try to create together. Several studies on brainstorming in groups have found that output suffers when people collaborate to produce ideas. Such limiting effects likely occur because each person’s output interferes with others’ output, and people cannot keep track of the volume of ideas being shared. One particular study on group brainstorming found that being exposed to other people’s ideas reduced the number of different search areas that were explored, though the number of ideas produced in groups was comparable to the number of ideas that individuals generated. Additionally, people’s ideas tended to conform to the ideas being shared in the group (Kohn and Smith, 2011). Research has explored conditions that help reduce the interfering effects of group brainstorming, with the goal of making collaboration more effective, such as by having each individual generate their own ideas before coming together as a group to share those ideas.

Gist-Based Schemas and the Role of Memory Errors

Memory does not work by encoding verbatim bits of information like a computer or digital camera. Rather, it works by encoding experiences into gist-based schemas that allow people to think and make decisions more quickly and integrate new information with existing information in a way that often leads to a more accurate representation of what happened in the past and what will happen in the future. By encoding memories in the form of gist-based schemas, however, the way people remember can become vulnerable to distortion and bias, often leading them to recall things in a way that fits their general ideas or beliefs about what happened instead of what actually happened. This aspect of memory has important implications for creativity. Indeed, thinking of new ideas and creative solutions often requires the ability to synthesize and integrate information rather than compare and contrast isolated details. To benefit from prior experiences in the form of analogical transfer (discussed earlier), for example, one must be able to see the deeper underlying similarities between two situations and not just the superficial details.

Schemas can also serve as useful starting points from which to build upon what one already knows and implicitly incorporate new information that may be relevant to solving ongoing problems. When someone fails to solve a problem initially, they may set up a sort of web or trap to capture information that might be relevant to solving that problem in the future. To be effective, however, this process needs to be flexible and make connections that fit the gist of what is needed rather than something specific. In most creative contexts, after all, one rarely knows exactly what they are looking for. Given these considerations, it may not be surprising that people who are more susceptible to gist-based false memories (as demonstrated on the Deese/Roediger-McDermott task, in which participants study lists of words such as sour, candy, sugar, etc. for a later recognition test that contains critical lure words that are related to the list but were never actually presented, e.g., sweet), tend to perform better on RAT problems than participants who are less susceptible to gist-based false memories.

Constructive Processes in Episodic Memory

People rely on their imagination to simulate possible future or hypothetical events that are vivid and full of detail. In some sense, this type of mental simulation is an inherently creative act in that it involves imaging novel scenarios that have not yet occurred or that are unlikely ever to occur. People can engage in a sort of mental time travel that not only takes them back to the recent and distant past but the immediate and distant future. Evidence indicates a great deal of overlap between the cognitive and neural processes supporting remembering of past events and mentally simulating future events (Schacter et al., 2007). In this way, the

processes of episodic memory are decisively constructive, not reproductive—retrieval does not involve a verbatim replay of past events; rather, it involves the pulling together of various sources of information and experiences to recreate past experiences. Thus, according to the constructive episodic simulation hypothesis, episodic memory plays a key role not only in the recollection of the past but in the simulation of the future. People can flexibly recombine elements of past experiences in a way that supports the simulation of new and unexperienced scenarios. This process is not unlike those involved in creative brainstorming where one tries to imagine novel possibilities and solutions by recombining elements of existing knowledge and solutions. In this manner, the construction of episodically specific events may play a key role in the generation of creative ideas.

Recent evidence suggests that temporarily boosting the specificity of the episodic memory system through an episodic-specificity induction task can increase creative performance (Madore et al., 2015). In these experiments, participants who received the induction task were shown a brief video clip and then guided through a structured interview in which they were asked to recall as many specific details about the events of the video as possible. Participants in a control group watched the same video but were only asked to provide their general impressions. Creativity was tested in a later phase by having all participants try to think of unusual and creative uses of common objects (e.g., a newspaper). Compared to participants in the control group, participants in the episodic-induction group generated a greater variety of novel uses. When prompted to describe an imagined future event that could happen to them, participants in the episodic-induction group also included relatively more detail in their descriptions, thus showing that the manipulation boosted not only the variety of uses on the AUT, but the level of detail used when imagining the future. These and other results suggest that a common set of mechanisms may underlie episodic retrieval, future simulation, and creative generation.

Sleep, Memory, and Creativity

Anecdotal descriptions of sleep-induced insight are common, both among the general population and among famous scientists and artists. (see Dreams) Many people have reported going to bed at night only to find their problem solved or a creative idea sprung to life by the time they wake up in the morning, sometimes reporting the insight came to them in the form of a dream. Laboratory research has suggested there may be some truth to these claims. In general, sleep has been shown to play an important role in memory consolidation: stabilizing recently learned experiences into long-term memory, integrating those experiences with existing memories, and extracting new rules and generalizations. Such processes are not only critical for the adaptive functioning and updating of memory, but for facilitating creative insight and problem-solving.

In one laboratory study, participants were given RAT problems either before taking a nap or spending the same period awake. They were then given a second opportunity to solve the unsolved problems. Participants who took a nap involving REM sleep solved significantly more of the unsolved problems than participants who did not take a nap (Cai et al., 2009). Presumably, sleep allowed for the target solution words, which were exposed to participants as part of a seemingly unrelated task after the first problem-solving attempt, to become integrated with the RAT problems in memory, thus potentiating the participants' ability to solve the problems on their second attempt. Other research has shown that participants can gain insight into more direct ways of solving problems or make more generalized inferences about the relationships between different stimuli after a night of sleep than after the same period awake. Additionally, sleep has been shown to facilitate analogical transfer between problems. Beyond the updating and integrating mechanisms of memory consolidation, sleep may also facilitate creativity by causing a change in context that allows people to forget the information causing mental fixation.

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Mental Models

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Glossary

Causes variables held to give rise to certain outcomes

Events actions taken to change the status or operation of a cause

Mediators variables that intervene between a cause and outcome

Mental Models linkage of causes to event outcomes

Moderators variables that condition the operation of a cause

Sensemaking understanding complex, novel events

Shared mental models mental models shared among members of a team working on a project

Strategies approaches or procedures that help people think about how to change the status of causes

Mental Models

Frank Lloyd Wright is widely considered one of the most creative architects of the 20th century. When one examines his work, however, a model of housing is evident in his early Prairie school work to his later work such as Fallingwater. It is a model which holds buildings should be embedded in their environment with limited embellishment. Einstein's general theory of relativity reflects a model of how energy and gravity operate at a macro, structural, level in our universe. Guilford's work on creative thought stresses divergent thinking—the production of alternative solutions.

All of the cases cited above point to a key conclusion: the work of eminent creative people seems bound together by an underlying theme or a way of viewing the domain in which they are working. Put differently, creative people seem to bring to their work a unique understanding of the phenomena of interest. Rouse and Morris (1986) argued that understanding of events in a certain performance domain is based on the mental model people use understand action, and action outcomes, in this domain.

This entry will examine how mental models contribute to creative performance, the production of original, high-quality, and elegant solutions, to complex, novel, and ill-defined, or poorly structured, problems. How shared mental models among team members contribute to the production of innovative new products and processes will also be considered. And finally, there will be a discussion of how people acquire and apply viable mental models in creative efforts. Before turning to these issues, however, let's examine what is meant by the term mental model.

Structure of Mental Models

Goldvarg and Johnson-Laird (2001) provided the most widely accepted definition of what is meant by the term mental models. They argued that in its simplest form, a mental model is the imposition of a cause-outcome linkage. In other words, the level at which a cause is operating is held to give rise to a certain outcome. Thus, a mental model common in the work domain holds that high job satisfaction gives rise to better job performance. Given this assumption, if you want my employees to perform better, you should take actions that will make them happier in their jobs. This observation is important because it underscores the point that mental models are inherently action oriented—causal assumptions specify potential actions to change the status of the cause. And, mental models are inherently adaptive. Mental models specify what outcomes a person should seek or avoid.

Of course, the description provided above of a simple mental model points to just how complex mental models may be. The first issue is what are the causes of concern? Yes, job satisfaction might cause job performance, but so might general intelligence. Second, what is the strength of the assumed relationship between each cause and the outcome of interest? Third, is the operation of a cause

contingent on the presence of certain conditions, a moderator, and what is the strength, or importance, of these moderating variables? Fourth, do causes operate directly on the outcomes of interest or is their influence indirect operating through another cause—a mediator? For example, does greater job satisfaction increase work motivation with work motivation resulting in better job performance? Fifth, what actions can be taken to increase a causal operative and how big will the effects of each action be? Sixth, how do the effects of actions on causes and outcomes unfold over time? Seventh, under what conditions will a given action prove effective, or ineffective, in changing the status of one or more causes, bearing in mind actions taken to increase one cause may decrease, or interfere, with the operation of other causes. Clearly, mental models can be very simple or highly complex.

Moreover, mental models can be accurate or inaccurate. Thus, in accounting for outcomes, a person may assume the correct causes are operating or use causes that are incorrect—causes that do not actually affect the outcomes of interest. In fact, prior studies examining the development of mental models of leadership over the course of peoples' careers found that mental models slowly, over time, become more accurate in that the causes articulated are those that actually are important.

Mental models are noteworthy for another reason. The causes and outcomes embedded in mental models provide a framework for integrating experience gained in working in a domain. Prior studies showed that plans for action are formulated through case-based, or experiential, knowledge. It has been argued that assumptions made about causes and outcomes are used to structure, or organize, experiential knowledge. Thus, not only are mental models built from experience working in a domain, mental models also provide a way of organizing and accessing this experience.

It should also be recognized that mental models are not emotionally neutral vehicles. People derive identity from the mental models they have constructed. Thus, model congruent and model incongruent events will induce affective, emotional, reactions. Moreover, people will act to "protect" their mental models, discounting events that might be taken to undermine their mental model. Indeed, it has been found when experts make errors, they often arise from routine application of a personally valued, expert, mental model.

Given their impact on plans and identity, many have sought to measure peoples' mental models under the assumption that differences in peoples' mental models will give rise to differences in performance. One technique used to appraise mental models is concept linkage, which includes indicating strong links between a given set of causes and/or causes and outcomes. Another technique used is cross association, or the associational linkage of certain words, or concepts, related to actions to be taken in a given domain. A third technique used is to ask people to draw, or illustrate, their model of a certain phenomenon. A fourth technique is to map concept linkages to the concept linkages used by recognized experts working in a field.

Regardless of the technique used to appraise differences in people's mental models, what is clear is that differences used by people to understand events arising in a given domain are strongly related to observed differences in peoples' performance. Thus, [Marcy and Mumford \(2010\)](#) showed that different content and structure of peoples' mental models for understanding university operations influenced their performance on a university simulation gaming exercise. Other work showed that more viable mental models are related to people's ability to cope with, perform well in, and address critical issues that arise in their jobs. In this regard, however, it is important to bear in mind the observations of [Rouse and Morris \(1986\)](#) with regard to the impact of mental models on performance—mental models appear to be most critical to performance when people are presented with novel, complex, high stakes events.

Mental Models and Creative Performance

Of course, creative problem solutions arise when people are presented with complex, novel, ill-defined, or poorly structured, problems. Thus, there is reason to suspect that peoples' mental models will also influence their performance on creative problem-solving tasks. In one of the earliest studies along these lines, [Finke et al. \(1992\)](#) asked undergraduate participants to draw aliens with the resulting drawings being appraised for originality. Notably, however, in drawing aliens, participants tended to preserve key features of biological life encountered on earth. Thus, most drawings preserved bilateral symmetry and eyes even though this requirement was not imposed—and alien life may not require bilateral symmetry or eyes.

Somewhat more direct evidence in this regard was provided by [Simper et al. \(2016\)](#). In this study, undergraduate participants were presented digital concept maps illustrating linkages among various concepts, or alternatively, participants were asked to write a story using a simple list of relevant concepts. Finding indicated that presentation of concept maps resulted in the production of more creative stories—especially with respect to judges' appraisals of story clarity.

In another study along those lines, [Malycha and Maier \(2017\)](#) asked participants, again undergraduates, to work on the product improvement task drawn from the Torrance tests, and the fluency, flexibility, and originality of the ideas generated was assessed. Complexity was manipulated by imposing (high complexity), or not imposing (low complexity), constraints. Participants were asked to illustrate concept linkages relevant to the problem, illustrate concept linkages using a template, or neither. They found that asking participants to illustrate their mental models resulted in the production of substantially more creative ideas ($d = 0.80$) than simple note taking—the control condition. Moreover, the strongest effects of asking participants to illustrate their mental models emerged when the conditions of task performance were more complex.

Clearly, specifically activating illustration of mental models, contributes to creative idea production. The questions that arise at this juncture, however, are 1) Does having a "better" mental model for understanding a task contribute to better performance in solving creative problems—not just simple idea generation? And, 2) What is the structure of viable mental models that result in the production of creative problem solutions? These issues were addressed in a study by [Mumford et al. \(2012\)](#).

Mumford and his colleagues examined peoples' ability to solve two, rather different, creative problems. One problem involved creating a plan for leading a new experimental secondary school. The other problem involved formulating an advertising campaign for a vintage footwear and apparel firm. Solutions to both problems, provided by some two hundred undergraduates in each study, were appraised by judges for quality, originality, and elegance. Prior to starting work on these problems, participants were asked to complete a self-paced instructional program, using a sports management illustration, where they were shown how to illustrate their mental models. Prior to starting work on the education task, or the advertising task, they received an email from a consulting firm on the education task, or from their putative supervisor on the advertising task, where a list of relevant concepts drawn from the literature was presented. Participants were then asked to illustrate their mental model for understanding the problem at hand using these concepts. Fig. 1 provides an illustration of one mental model formulated for the advertising study.

A panel of judges was asked to appraise objective and subjective features of the mental models provided. Objective features included number of critical causes, number of cause-outcome linkages, number of moderators/mediators, number of positive causes, number of negative causes, and number of reciprocal relationships. Subjective features included model coherence, novelty, logic, complexity, completeness. When these ratings were regressed on ratings of solution quality, originality, and elegance, multiple correlations in the low.30s were obtained. Thus, mental models appear to contribute to creative problem-solving. Moreover, it was found the most creative solutions were provided by people who used high importance, but not basic, concepts—who also took into account moderators and mediators of causal relationships. These mental models were, furthermore, coherent and logical, albeit not necessarily especially novel.

Mental models, of course, are an organizational structure, thus coherent organization of critical causes is more important than novelty. This observation, however, broaches a new question. How do people work with experiential cases embedded in these models to produce more original, high-quality, and novel problem solutions? One way this might occur is to change the structure of the mental model. Another way this might occur is to adapt the mental model to the demands of the performance setting at hand.

Hester et al. (2012) and Peterson et al. (2013) have examined the value of changing mental model structures. In both studies the education and advertising tasks were again presented, following instruction as to how to illustrate mental models in terms of structure, and the originality, quality, and elegance of problem solutions was assessed. In the Hester et al. (2012) study, participants were

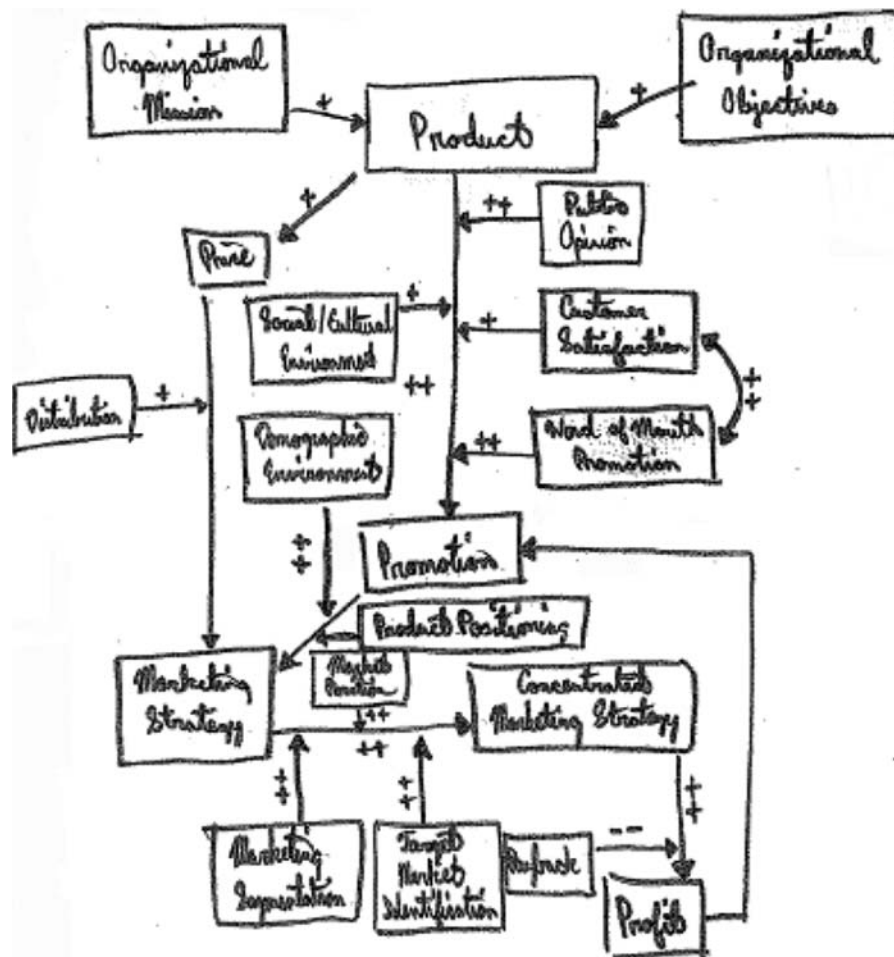


Figure 1 Illustration of one mental model formulated for advertising study.

also asked to complete a set of self-paced training modules where they were presented with strategies for identifying causes: work with 1) critical causes, 2) causes that impact multiple outcomes, 3) causal interdependencies, and 4) causes that have negative effects. In the [Peterson et al. \(2013\)](#) study participants were presented with self-paced training modules where they were presented with strategies for identifying constraints: work with 1) resource constraints, 2) system capability constraints, 3) user skill constraints, and 4) goal constraints. It was found that training in both analysis of causes and analysis of constraints resulted in the acquisition of stronger mental models and the production of more creative problem solutions—solutions of higher quality, originality, and elegance, with such training proving especially valuable for people evidencing creative talent or potential.

Another set of studies by [Barrett et al. \(2013\)](#) and [Robledo et al. \(2012\)](#) examined the value of adapting extant mental models to the performance domain at hand. In the [Barrett et al. \(2013\)](#) study, people were asked to complete a set of self-paced instructional modules where they were taught to consider issues involved in developing and applying creative ideas: think about 1) How ideas will affect user groups, 2) The setting for idea implementation, 3) User group preparation and 4) Sustainability of the idea in context. In the [Robledo et al. \(2012\)](#) study, people were asked to complete a set of self-paced training modules where they were taught to think about potential errors arising in idea implementation: think about 1) error criticality, 2) error impact on stakeholders, 3) error controllability and 4) subsequent errors that might arise. In these studies, the instructions described above resulted in acquisition of stronger mental models and production of problem solutions of higher quality, originality, and elegance.

Taken as a whole, these findings indicate that people can acquire stronger mental models that lead to more creative problem solutions by manipulating model structure and/or adapting model content to the performance setting at hand. Of course, other techniques may also encourage the acquisition of stronger mental models in creative problem-solving efforts, and structural manipulation and adaptation might not be the only mechanisms of relevance. Nonetheless, these findings, along with those obtained in the studies discussed earlier, make a basic point—peoples' mental models appear to account for significant differences in their ability to solve problems calling for creative thought.

Collective Mental Models

Not only are mental models relevant to individual-level creative performance, they also appear critical to innovation. To turn creative ideas into viable innovative new products or services, multiple people, teams, and multiple stakeholder groups, must be drawn into the effort. If different people, or different stakeholder groups, have markedly different understandings of the nature and significance of the creative idea, or creative problem solution, performance and innovation will suffer. In fact, because innovative efforts often require chains of creative problem-solving efforts, for example, a new drug may require subsequent new ideas about how to manufacture the drug, the availability of a shared understanding of the idea at hand, and its implications, may be especially important.

Shared understandings in teams, or firms, are held to be based on team members evidencing a shared mental model. The existence of a shared mental model among team members is commonly identified by either appraising the similarity of content maps through a path finder analysis, or alternatively, appraising the amount of variance evident among team members in their appraisal of the importance of issues or concepts—note, low variation is held to provide evidence indicating the existence of a shared mental model.

A variety of studies have indicated that the availability of shared mental models contributes to team performance. For example, [DeChurch and Mesmer-Magnus \(2010\)](#) conducted a meta-analysis study of the availability of shared mental models and team performance. They found the availability of shared mental models resulted in better task execution (e.g., planning, goal setting, coordinating), greater team motivation (e.g., confidence, morale, identification), and, ultimately, better performance. In fact, the contribution of shared mental models to performance also appears to generalize to teams working on tasks calling for creative performance.

For example, [Santos et al. \(2015\)](#) studied the performance of one hundred and sixty teams who were asked to work on a complex managerial simulation exercise. Team members completed a survey describing their self-perceived creativity and creative self-efficacy near the end of work on this simulation exercise. Performance was assessed through “end of game share price”. The availability of shared mental models was established through agreement evidenced among team members with respect to task demands and team processes. Creativity was found to be strongly positively related to team performance. The availability of shared mental models, however, was found to be positively related to team creativity and reduction of conflicts among team members. Thus, the availability of shared mental models does appear to contribute to both creativity and performance within teams.

The availability of shared mental models among team members, however, is not simply a matter of team members' impressions of their own creativity. [Mumford et al. \(2001\)](#) asked teams to generate ideas for solving a set of creative problems, with the number of ideas generated serving as one measure of creativity. Teams were also asked to provide solutions to these problems where judges appraisals of solution originality and solution quality provided another measure of creativity. Shared mental models were induced, or not induced, by providing team members with training before they started work on the creative problem-solving task. They found that teams sharing a mental model not only produced more ideas relevant to the task, they also produced more creative problem solutions—solutions of higher quality and originality.

In addition to task-relevant training, a variety of other techniques might be used to induce shared mental models in creative teams. It can be argued that three key activities in addition to training, or cross-training in other job functions, contribute to team acquisition of shared mental models. First, leaders should actively, and clearly, articulate their personal mental model for

understanding the creative effort. Second, after action reviews of work accomplished should include analyses of performance, and team feedback, with respect to shared mental models. Third, ongoing communication among team members vis-à-vis the creative effort should be encouraged to spur the emergence of shared mental models.

Developing Mental Models

Our foregoing observations, of course, suggest that mental models, and shared mental models, can be developed. This statement, however, broaches another question: what techniques might have value for developing viable mental models and viable shared mental models as individuals and teams undertake creative efforts? In fact, four techniques: case analysis, goal analysis, forecasting, and active deep reflection, all appear to contribute to the acquisition of viable mental models.

Perhaps the most straightforward approach to developing peoples' mental models may be found in training, or educational, interventions intended to help people work with the two core elements of all mental models—causes and outcomes or goals. The value of training people to work with causes was demonstrated in a series of studies by [Marcy and Mumford \(2010\)](#). In the first study, undergraduates were asked to solve six creative problems drawn from business and education domains. Judges appraised the originality and quality of the resulting problem solutions. Prior to starting work on these problems, however, participants were asked to complete seven self-paced instructional modules where they were provided with more effective strategies for working with causes: work with 1) causes that have large effects, 2) causes that effect multiple outcomes, 3) causes that can be manipulated, 4) causes that can be controlled, 5) causes that operate together, 6) causes that operate synergistically and 7) causes that have direct effects. It was found that this training in causal analysis strategies contributed to the production of more creative problem solutions.

In the second study, participants were asked to work on an educational leadership simulation exercise. Again, participants were, or were not, asked to complete the seven training modules bearing on viable causal analysis strategies. In this study, however, it was found not only that causal analysis training resulted in better performance, it also resulted in the acquisition of stronger mental models for understanding the performance setting at hand. Thus, training causal analysis, apparently, contributes to the acquisition of stronger mental models and better performance on creative simulation exercises.

Less attention has been given to the analysis of outcomes or goals. However, at least one study, a study by [Strange and Mumford \(2005\)](#), points to the value of developing mental models by encouraging analysis of potential outcomes or goals. In this study, participants were asked to assume the role of principal of a new experimental secondary school and participants were presented with good, or poor, as well as successful, or unsuccessful, cases of describing prior educational interventions. They were instructed to analyze these cases with respect to causes, goals, both, or neither.

It was found that analyzing good cases with respect to causes and bad cases with respect to goals resulted in the most creative problem solutions. Thus, there is reason to suspect that goal analysis strategies might also contribute to the acquisition of stronger mental models. This study, however, is also a reminder that viable mental models may emerge as a function of the cases, or experiences, on which they are based. Thus, in developing stronger mental models, it may be desirable to provide people with viable case prototypes which serve to illustrate critical cause-outcome linkages.

The [Strange and Mumford \(2005\)](#) study, however, is noteworthy for another reason. In this study, a manipulation was made where people were asked, or were not asked, to reflect on their own personal experiences when considering these cases. It was found that deep self-reflection contributed to the production of more creative educational plans. Thus, it seems plausible to argue that ongoing reflection on experience, potentially including unusual experiences or new, broadening, experiences, might also contribute to the acquisition of stronger mental models and the production of more creative problem solutions.

In this regard, however, reflection need not always be tied to actual past experiences. Prior studies showed that more extensive forecasting of the potential outcomes of planned actions contribute to both the production of higher quality, more original, and more elegant solutions to creative problems as well as more effective execution of key creative thinking processes (e.g., idea generation, idea evaluation). What is of note here, however, is that extensive reflection on the nature, success, and potential outcomes of forecasted actions may also contribute to the acquisition of stronger mental models.

Conclusions

Clearly, a variety of techniques can be used to help people acquire the kind of mental models likely to contribute to creative thought. Although more research is needed on how mental models contribute to creative problem-solving, for example, how should mental models be structured, and how should they be appraised, the findings to date indicate that mental models may be a powerful force shaping the nature and success of peoples' creative thought. These findings point to a need for more work intended to help us learn how to develop viable mental models.

In fact, work along these lines could be especially important because mental models may either inhibit or facilitate creative thought. Remember, [Finke et al. \(1992\)](#) findings indicated that mental models inhibited creative thought. Other work indicated the formation of viable new mental models often provides the basis for eminent achievement—in fields such as science, advertising, and architecture. Given these complex effects of mental models on creative achievement, there is clearly a need to know more about the exact structure of mental models that makes creative thought possible. The authors hope this entry provides an impetus for further work along these lines.

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Mentors

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Introduction

Developing the efficacy and drive to become an active contributor to creative thought and ventures can be a daunting task. Creativity is often viewed as an inherent trait afforded to only a few individuals. However, taking a social or developmental view of creativity in which individuals can develop an ability to be creative, we can consider the impact of contextual variables and key supporting relationships on the involvement in creative activities and subsequent creative achievement. An important relationship to consider here is the connection between a mentor and a mentee. Indeed, in areas as diverse as science and film, many exemplars of creative achievement benefited from relationships with mentors. James Watson, co-discoverer of DNA, learned from Max Delbruck, an eminent scientist and recipient of the Nobel prize in physiology or medicine. More recently, Steven Spielberg served as a mentor to fellow director J.J. Abrams. Through these illustrative examples we gather that mentoring often serves as a means of interpersonal learning that can support individual creative development.

Broadly, focusing on creativity, mentors provide support and developmental opportunities to their mentee that can encourage creative idea development and generation. Accordingly, this entry focuses on the social and developmental view of creativity by examining the relationship between mentorship and creativity. The chapter starts by outlining what is meant by mentorship and the roles mentors serve. Subsequently, by highlighting key studies in this area, the impact of mentoring actions on mentee creative learning and performance is reviewed. Finally, the steps required to promote mentorship for the unique benefit of creative performance are presented.

Mentoring

Defining Mentoring

To understand what is meant by mentoring, a few component parts need to be considered. The most prototypical representation of mentorship is the wise leader, parent, or educator imparting guidance and knowledge onto those below them (the follower, the child, or the student). However, to start, mentoring can be defined through both formal and informal relationships, such that the mentor-mentee connection exists through official or unofficial paths. Mentorship can occur formally as the mentee is assigned to a specific mentor to receive guided assistance and development. An example here is the connection between a manager and his or her team members. Alternatively, informal mentoring can occur as the mentee seeks support or the mentor provides unrequested guidance. This distinction is important as mentoring moves past the consideration of those in a formal role and instead focuses on the specific relationship development between a mentor and mentee. Thus, mentorship can be provided formally or informally through multiple individuals across different settings.

However, an added distinction that nuances understanding of mentorship is the difference between mentoring relationships and mentoring behaviors. To illustrate, consider the connection between two peers or colleagues with one passing along career advice to the other. In this case, the individual is conducting a mentorship behavior, but a mentor-mentee relationship may not be specified or established. The mentor behavior may be a claim to take on a mentorship role or develop a mentoring relationship in the future, but no established bond or connection has yet been formed. The mentor-mentee relationship requires, and is more clearly present, through the pairing of individuals or the long-term development of a mutual connection. As such, although any individual can conduct mentoring behaviors, an established formal or informal mentoring relationship is required to ensure a lasting and effective impact.

Three additional components add layers of nuance to an understanding of mentorship. First, mentorship requires two parties, the mentor and the mentee or protégé (used interchangeably throughout this chapter). Bearing in mind these two parties, mentorship can be broadened to consider both groups and individuals, which allows for attention on situations ranging from

a leader providing guidance to their team to an academic advisor individually connecting and supporting an advisee. As such, the study of mentorship can be broadly defined. Second is the role of both the mentor and protégé as active contributors. Mentorship is not a one-sided endeavor where the mentor is the primary contributor; both parties can play a pivotal part in developing and promoting mentorship. The mentor can seek out those in need of guidance or the mentee can find an individual who is willing to share his or her experience. Lastly, the guidance that the mentor provides or the mentee seeks can be for both professional and personal development. Thus, the mentor-mentee relationship can range in support from career-specific guidance to more intimate and interpersonal advice.

The distinctions established above serve to demonstrate the breadth and depth of mentoring. One could easily identify examples of mentoring across age groups, work and non-work settings, and for a variety of intentions and purposes. Multiple individuals can take on a mentor or protégé role. The definition of mentorship is a formal or informal relationship between two parties with the intent of professional or personal development.

What Do Mentors Do?

In applying this definition to promote the professional or personal development of an individual, scholars have debated the specific role mentors serve; yet, three main functions emerge as most commonly considered (Kram, 1988; Scandura, 1992). The first, psychosocial support, consists of the building of trust and intimacy between the mentor and mentee. For this function, mentors focus on behaviors that help enhance their mentee's self-efficacy and support their personal identity development, such as role modeling, friendship, counseling, and encouragement. The second function, career-related support, focuses on the mentee's vocational interests and development. Mentors, in this case, encourage mentee's pursuit of career-related goals, preparing them for hierarchical advancement through coaching and exposure to challenging and difficult assignments. The third function, role-based support, promotes mentees' development in their current position. Here mentors provide mentees with the guidance as to the appropriate behaviors required for their role and how to manage expectations properly. Across the functions of mentoring, learning is the common denominator, as the general purpose of mentoring is to teach and prepare the protégé to succeed in their field.

Before proceeding to a discussion of mentoring and creativity, it is important to note that not all mentoring relationships are the same. As such, a mentor-mentee connection is not required to satisfy all three functions specified above. It is possible for a mentee to have multiple mentors who each serve to provide a separate aspect of support. In addition, mentoring relationships are not as static as they have been portrayed here. In fact, mentorship can vary in its purpose, duration, and patterns of interaction. Thus, the established definition and functions should be used as a guide instead of a set of unwavering rules determining what is and is not mentorship.

Mentoring and Creativity

Does mentoring support the development of protégé creative ability, creative involvement, and creative performance? To answer these questions, a social and developmental view of creativity is required (Mathisen and Bronnick, 2009; Tierney and Farmer, 2002). An individual's creative identity and ability can be built and can progress over time through active engagement in activities or discussions with their mentor(s). This perspective moves away from the traditional image of creative ability and thought as a solitary and static concept toward a malleable and evolving interpretation. Supporting this idea, available evidence specifies the importance mentors hold on growing protégé creative performance and involvement. Generally speaking, studies on mentoring point to the critical role of mentoring in developing key outcomes such as mentee creative self-efficacy and creative performance.

Creativity is commonly defined as the generation of an idea that is both novel and serves a purpose (Amabile et al., 1996). However, in creativity research, the final idea is not the only component of interest. When discussing creativity, one can consider an individual's tendency or ability to be creative, an individual's efficacy or identity as a creative contributor, and an individual's final creative achievement or performance. Accordingly, mentoring can impact individual creativity development across all three of these areas.

The value mentors hold can be accessed through two distinct paths. The first path centers on the final creative performance of an individual. Here the mentor serves a direct role, as they help shape or mold the final creative idea or product by integrating their perspective or challenging the mentee to push further. In this case, the mentor might become personally involved in the idea generation, selection, and development process. Alternatively, the second path focuses on the mentee's involvement in creative ventures and their development of a creative identity. For this path, the mentor takes a more indirect role. In this case, the mentor may serve as a support system providing resources and guidance, or building the protégé's motivation to behave creatively. These paths demonstrate that the learning and growth provided by mentors can impact mentee creative performance directly or indirectly.

Further, each of the three functions of mentoring, psychosocial support, career-related support, and role-based support, have both direct and indirect paths by which mentoring behaviors influence protégé creativity. In providing role-based support, a mentor can serve as a role model to help mentees learn and determine appropriate actions and behaviors. In creativity specifically, role modeling can indirectly impact individual creativity by demonstrating the appropriate behaviors required for the creative process. For example, the mentor can demonstrate the actions needed to generate ideas, evaluate the utility of ideas, and indicate how to bring ideas to fruition. Here the mentor is not directly impacting the mentee's creative product or ideas, but instead representing

an appropriate path for the mentee to take. As such, the mentee is learning how to behave creatively and engage in creative idea generation. However, the mentor might also take a more direct path by demonstrating and helping craft a creative idea with their mentee. Further, career-related support, concentrating on career-advancement and navigation, can also take on a direct and indirect path to impact mentee creativity. Directly, the mentor can share knowledge or provide guidance to the mentee to develop their creative idea or move forward with a creative venture. Indirectly, the mentor can connect the mentee to individuals outside of their network to support the development of a creative venture or support and validate the mentee's career decision to engage in creativity. Finally, the mentor can provide psychological support by counseling or encouraging the mentee to be creative. Given that engaging in creativity can be an arduous endeavor, the mentor indirectly supports creativity by boosting the individual's creative identity and belief in their creative abilities.

Support for the direct impact of mentoring behaviors on creativity comes from recent work by [Cai et al. \(2018\)](#), in which an entrepreneurial leadership style was found to predict individual creativity. At a high level, entrepreneurial leadership is aimed at motivating and guiding followers toward creative opportunities and endeavors; however, at a behavioral level, it is similar to mentoring for creativity, specifically in the context of the manager-employee dynamic. Entrepreneurial leaders engage in mentoring behaviors such as motivating employees to engage in the creative process and building their confidence in their creative abilities (i.e., psychosocial support), as well as working directly with employees to generate ideas, consider alternative perspectives, and overcome challenges (i.e., role-based support). Thus, the ability of this leadership style to drive creative outcomes is an indicator of the potential for mentoring for creativity to do the same.

When [Form et al. \(2017\)](#) asked participants to think of a mentor who influenced their personal development, they discovered that more traditional components of mentoring (namely, providing psychological support, advancing domain-relevant skills, career-related support, and role modeling) were not directly related to creative performance. However, an interesting new component of mentoring, interpersonal tensions was significantly related to mentee creative achievement. Although these results should be taken with caution provided issues of generalizing from a single self-report sample, what is important to highlight here is that mentoring can impact creativity through a negative path (i.e., interpersonal tensions). The authors theorized that the interpersonal tensions participants reported with their mentor were a byproduct of added intellectual stimulation or critique received from the mentor. If a mentor is critical of a protégé's ideas and rigorously evaluates the value and potential utility of the idea, interpersonal tensions may emerge, but creative achievement will also be higher. The mentor is serving as a key agent in the development of more original and useful creative products.

Alternatively, as discussed before, there is also support for an indirect path from mentoring to creative achievement. For instance, [Bang and Reio \(2017\)](#), through a sample of working adults recognized the importance of developing an individual's creative self-efficacy. Creative self-efficacy refers to one's belief in their ability to generate creative outcomes, which plays a pivotal role in individual motivation toward and engagement in creative ventures. To develop creative self-efficacy the authors considered the benefits mentors can provide as coaches, feedback givers, role models, and overall support systems. In addition, in this study, the individual mentee's personal accomplishments (i.e., feelings of competence and successful achievement) were also considered as a source of creative self-efficacy. [Bang and Reio \(2017\)](#) found that both mentoring and personal accomplishments related to increased creative self-efficacy and the subsequent involvement in creative work. Thus, the mentor serves as an indirect impact on creative achievement by building and fostering the protégé's belief in their ability to produce creative outcomes.

Hinted at in the findings of the previous study is the mentee's individual qualities that draw in mentors and increase creative performance. Although some mentor-mentee relationships emerge naturally, there is evidence to indicate that high-achieving individuals seek out mentors earlier in their careers. For example, [Zuckerman \(1977\)](#) found that Nobel laureates tended to have eminent scientists as mentors and that those relationships were the outcome of an active, mutual search by young scientists and their future mentors. Further, [Mumford et al. \(2005\)](#), found that active pursuit of mentorship was a key difference between high- and low-achieving scientists. This finding indicates that it is important to consider individual mentee characteristics that might push them to seek a mentor, and thus boost their involvement in creative activities and build their creative identity.

[Liu et al. \(2015\)](#) identified two characteristics that are important for a mentee to consider to maximize their mentorship experience and increase creative achievement: learning goal orientation and impression management tactics. The first, learning goal orientation, is an aspect of one's personality that drives an active and consistent engagement in activities to develop and build one's abilities ([Dweck, 1986](#)). Individuals with a high learning goal orientation often seek challenging work assignments, pursue developmental opportunities, and enjoy difficult tasks. Second, impression management tactics are behaviors focused on developing desired social images to promote specific relationship benefits ([Wayne and Ferris, 1990](#)). Taken together, [Liu et al. \(2015\)](#) studied both of these characteristics in 917 formal mentor-mentee pairs. Their results indicated that having a high learning goal orientation leads to increased mentoring provided by the mentor and subsequent increases in protégé creativity. However, this relationship was stronger when the mentee engaged in mentor-focused or self-focused impression management tactics rather than job-focused tactics. Essentially, this study demonstrated that individuals who actively pursue learning opportunities such as mentorship are among those most likely to receive mentoring, in particular when they take steps to be perceived as competent and deserving of the mentor's investment. These results demonstrate that the mentee can also play an active role in increasing their creative performance.

Overall, the studies presented above examined the effect of mentoring on creativity. The key takeaway from these results is that the underlying processes by which mentorship impacts mentee development are learning and growth. Mentors can increase protégés' creativity by impacting their personal identity growth (increasing creative self-efficacy), personal skill development (role

modeling the creative process or providing developmental tasks), and personal idea or product improvement (critically evaluating and increasing originality and usefulness of mentee ideas).

Promoting Creativity Through Mentorship

Together, the findings outlined in this chapter provide a variety of practical considerations for both individuals and organizations seeking to foster creativity through mentorship. Special attention must be paid to ensure that mentoring relationships, whether formal or informal, are structured in such a way that protégés receive the psychosocial, career-related, and role-based support they need to increase their creative self-efficacy and attain creative achievement. The remainder of this entry focuses on a series of actions that individual mentors can take to more effectively support mentees, along with recommendations for organizations seeking to create mentoring programs for their employees or members.

Before any mentoring occurs, it is important to carefully match mentors and protégés. While it might be tempting to pair mentors and protégés based on demographic diversity, it is more beneficial to pair them on characteristics like similarity in attitudes, values, beliefs, and personality (Eby et al., 2013). When mentees are similar to their mentors in these areas, they tend to report higher levels of support from their mentor and higher overall relationship quality. However, although similarity is necessary to establish a relationship, too much similarity can also prevent the mentee from developing independently and establishing their own path (Simonton, 1984; Runco, 2014). Thus, in matching mentors and protégés, it is important to seek an optimal level of similarity. After a mentor pair is matched, a second key step is to establish a shared understanding of the purpose and rules of the mentoring relationship. The goal here is for both the mentor and mentee to communicate their respective goals for the relationship, preferred method of interaction, and expectations for accountability. These two steps will set the foundation for a successful mentoring relationship.

In some ways, mentoring for creativity is similar to any other form of mentoring. However, there are specific areas where mentors can add to the experience in ways that will promote their protégés' creative self-efficacy and overall creative performance. To foster creativity, mentors should:

- **Actively listen to mentees' ideas and experiences.** By establishing rapport and an environment of acceptance and open communication, mentors can inspire creativity and afford mentees the freedom to express creative ideas.
- **Help mentees shape an inspiring vision or goal for their career.** An important part of mentorship is to help mentees develop goals that are both practical and aspirational. Mentors can then assist on the path to achieve those goals by using their own knowledge and experiences to provide advice on navigating workplace processes, learning about the creative process, and acquiring job-specific skills. When practical, mentors can also provide accountability.
- **Be encouraging of mentees' creative endeavors.** One of the key outcomes of mentorship is an increase in mentees' creative self-efficacy. Mentors can help foster that self-efficacy by showing enthusiasm for ideas, providing constructive feedback and suggestions for improvement, and voicing confidence in mentees' abilities.
- **Challenge or critically (but constructively) evaluate mentees' ideas.** As mentees increase self-efficacy and creative ability, mentors can push the mentee to be more creative by challenging their ideas. This should be done constructively, such as pointing out concerns the mentee might not have considered or encouraging them to look at their idea from a different perspective. An important part of the creative process is evaluating ideas, and mentors can help mentees learn to more effectively do that.
- **Provide guidance when mentees face challenges in their creative process.** The aim here is not to solve mentees' challenges or generate creative ideas for them. Rather, mentors could discuss how a problem might be addressed, how they have handled such challenges in their own career, or provide introductions to those in their network who may have expertise or insight. Mentors should help mentees gain the ability to navigate such challenges on their own in the future.
- **Provide developmental opportunities to mentees to encourage their growth and creativity.** When possible, mentors can provide hands-on experiences in the creative process. This could include allowing mentees to participate in or observe a brainstorming session, connecting them to others in the mentor's network, or (if the mentor is a supervisor) giving them a stretch assignment that requires creative idea generation.

Each of the actions outlined above can be used in either formal or informal mentoring relationships. However, organizations seeking to implement formal mentoring programs can increase the effectiveness of mentoring in a few ways. First, when mentoring for creativity, early engagement in mentoring is one of the keys to success (Ligon et al., 2011; Mumford et al., 2005). As such, organizations should be sure to make mentoring available for recently hired employees and those who are newer to the field. Second, in some cases, it can be valuable to have multiple mentors with different perspectives and insights (Murphy and Kram, 2010). Organizations could structure programs so that mentees have a primary mentor who is responsible for more psychosocial and role-based support, along with a secondary mentor who is more senior in the organization and can provide longer-range, career-related support. Finally, as with any new program, organizations should provide training to those involved in the mentoring program – both mentors and mentees – to ensure they understand how to maximize the relationship and work together effectively.

These actions, undertaken by individual mentors or by organizations, can help individuals develop the drive and efficacy needed to be a successful contributor to creative thought and ventures. By providing psychosocial, career-related, and role-based support, mentors can boost mentees' creative identity and self-efficacy, and thus inspire increased creative achievement.

Summary and Conclusions

This review of the impact of mentoring on creativity leads to some thought provoking conclusions. The most important conclusion is that creative ability can be developed. Perhaps even more critical, research indicates that mentoring can support the development of creative ability. The impact of mentoring in creative thought and performance arises through the career-, psychological-, and role-based support mentors provide their mentee. Mentorship can provide the foundation for an individual to understand the creative process and build their creative self-efficacy to increase their creative performance. Thus, it is clear that high quality mentorship improves an individual's creative process and confidence in their ability to be creative. Mentors can challenge individual ideas and build upon them to develop a more creative final product. Given the complexity of generating, constructing, evaluating, and implementing an idea, mentorship appears to provide the reassurance or constructive criticism needed to ensure success. More centrally, high-quality mentorship appears to increase creative performance.

In addition, although mentors emerge as a key resource in creativity training and development, the influence of protégé actions and characteristics cannot be disregarded. Multiple aspects of the mentee's personality, beliefs, values, and behaviors can impact the quality and strength of the relationship between mentorship and protégé creative performance. Thus, when promoting mentorship it is important to consider both the aspects of the mentor-mentee relationship and the protégé's specific individual characteristics.

The multiple paths by which mentoring can impact individual creative performance are nuanced. However, by understanding how mentoring influences creative thought and performance it is possible to develop interventions and formal mentoring programs to encourage and promote creativity. Hopefully the steps presented here will lay the foundation for future work intended to nurture a greater impact of mentoring on protégé creative performance. Given the value in fostering individual creativity, any effort to develop creative ability is time well spent.

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Meta-Analyses

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What Is Meta-Analysis?

Meta-analytic studies have become popular in educational and psychological research and creativity is no exception. As empirical evidence accumulates, scholarly understanding of creativity is expanding, although controversies are also emerging. Meta-analyses are useful to take stock of the existing empirical evidence reported by quantitative studies and resolve some of the controversies in the field. This entry briefly explores meta-analysis as a research methodology and then presents a summary of key findings from meta-analyses on creativity.

Definition, History, and Purposes

Gene Glass is the psychologist who coined the term, “meta-analysis.” He defined it as “the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings” (Glass, 1976, p. 3). Meta-analysis has a relatively short history as a research methodology. The emergence of the term itself came from a synthetic process. Eysenck (1952) had questioned the benefits of psychotherapy for patients. In response, Smith and Glass (1977) disagreed and compiled 375 studies on the impact of psychotherapy showing its benefits. The same team also published another meta-analysis on the relationship between class size and academic achievement. They called this “meta-analysis,” but they were not the only ones experimenting with the new method. Around the same time, Smith and Glass were working on the impact of psychotherapy, Schmidt and Hunter (1977) were aggregating the validity evidence of employment tests, and Rosenthal and Rubin (1978) were synthesizing studies on interpersonal expectancy effects. The emergence of meta-analysis seems to be an example of a case of “multiples” in scientific discovery [see Matthew, Pygmalion, and Founder Effects].

Long before the term came into use, researchers from different fields such as statistics, physics, and social psychology aggregated different study findings to obtain an overall estimate (See Cooper and Hedges, 2009). Olkin (1990) cited R. J. C. Simpson and Karl Pearson’s work on fever inoculation as an early example. The first meta-analysis on creativity (i.e., Rose and Lin, 1984) was on the impact of creativity training. This subject turned out to be the most popular topic in meta-analysis over the years.

Meta-analyses combine studies on a given subject to obtain an overall estimate of relationship, difference, activity, or probability. It is no coincidence that this approach emerged from and is most often used in the field of psychology, because research results indicate sizable variability particularly in this field. While obtaining a general estimate over varied study outcomes is helpful, equally important and interesting is the attempt to explain this variability. This is the reason why the term, “moderator,” is of great importance in meta-analysis. Moderators are used to explain the variability in study outcomes that occur due to theoretical or methodological reasons. In practice, these moderators could be continuous or categorical variables that account for a variation in effect sizes. They typically serve as an independent variable. Glass et al. (1981) adapted specific

statistical procedures of the analysis of variance and multiple regression to meta-analysis. Moderators use it to explain the variability in effect sizes, which are used as the dependent variables. Therefore, although moderators help explain why effect sizes vary from one condition to another in the statistical sense, they serve as predictors or independent variables as part of the model-building process. This is the point where meta-analysis goes beyond a simple arithmetic mean calculation. The process of moderator identification and the coding process require a strong knowledge of research methodology and the literature. Therefore, two different meta-analyses may not report the exact same results, depending on the modeling, moderator categories and statistical analyses.

Strengths of Meta-Analyses

The popularity of meta-analyses goes beyond pragmatic reasons such as citation counts. Meta-analyses use study outcomes reported as their data, whereas most primary research in psychology, business and education use data from human subjects. The aggregation of conducted studies provides a big picture of research on a given subject. When a meta-analysis provides a clear pattern, this brings about more confidence in the research findings, which in turn, guides and facilitates future research and policy development. In this sense, meta-analyses help bring clarity to diverse research reports.

Compared to literature reviews, meta-analyses are more objective and less vulnerable to researcher bias as a result of a clear structure around the statistical procedures. Moreover, meta-analyses give researchers an opportunity to test hypotheses that may not easily be possible through primary research. In this sense, it is a distinct form of scholarship.

Criticism of Meta-Analyses

Meta-analyses have been criticized in different ways since the very beginning of the method itself (Eysenck, 1978), and issues have been discussed in later works (e.g., Ioannidis, 2016; Sharpe, 1997). Three major issues raised by these researchers are the probability of combining studies of different kinds, which invalidates outcomes, since this is analogous to combining “apples and oranges.” Second, meta-analyses outcomes are criticized for being biased because of the overrepresentation of published work over conducted, but unpublished, studies that are more likely to yield non-significant results. This is known as the “file-drawer effect” or “publication bias,” and different methods have been developed to identify or address this issue (Gurevitch et al., 2018). One recommended solution is to seek and include “hard-to-find” data, also known as “grey literature.” It consists almost all studies beyond journal articles, including unpublished works. Third, included studies may vary in terms of their “quality” while the inclusion of low-quality studies may reverse or change the findings. Therefore, researchers may prefer excluding studies with no control group or post-test, only designs that avoid the problem of “garbage in, garbage out.”

As a relatively new methodology, researchers suggested new approaches on some of these issues, and the software programs are often quick to adopt them into their packages. Acar et al. (2019) discussed each of these challenges in the context of creativity research. To give more structure to the meta-analyses and ensure quality standards, researchers and practitioners may turn to published guidelines such as the American Psychological Association’s Meta-Analysis Reporting Standards (MARS) and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

With the development of these guidelines and the increasing number of empirical studies on the method itself, meta-analyses have become a major form of research. Creativity researchers have exploited this method extensively. Given that meta-analysis provides a general perspective on a particular research question, a review of all conducted meta-analyses provides a board perspective on the field of creativity. The next section does just that in order to take stock of creativity research based on empirical data.

A Thematic Analysis of the Published Meta-Analyses on Creativity

Meta-analytic studies are important for the field of creativity because they provide an empirical summary and overview of decades of research in the field. They not only provide insights on some controversies in the field but also reveal patterns that were not clearly visible in the primary sources. In this section are summarized published meta-analyses on creativity according to following thematic clusters: creativity training, intelligence, achievement and performance, psychopathology, motivation, neuroscience, personality, mood and problem-solving. Studies that did not fit any of these categories are presented in the “other” category.

Creativity Training

The impact of creativity training is the most popular subject of meta-analyses. The first meta-analysis on creativity (Rose and Lin, 1984) addressed this issue and, as of 2018, eleven others were identified on this subject. Rose and Lin (1984) examined the effect of long-term creativity training on creativity as measured by TTCT. They found that creativity training programs have a moderate impact on verbal creativity, especially on verbal originality. Similarly, Bertrand (2005) demonstrated that training moderately improves creativity and the increase was higher verbal creativity figural creative ability. Interestingly, the frequency of the length

of training did not have an impact on creativity. Later on, [Ma \(2006\)](#) focused on the effectiveness of creativity training and found a large effect of training programs on creativity. In terms of divergent thinking outcomes, originality had the highest effect size, whereas elaboration had the smallest. The kind of instruments measuring creativity, the experimental design and the duration of training did not significantly influence the creativity level.

[Scott et al. \(2004a\)](#) revealed that creativity training programs typically improve performance across criteria, settings and target populations. In another meta-analysis by the same team of researchers ([Scott et al., 2004b](#)), the type of training was a significant factor in enhancing creativity. Specifically, idea production and cognitive training were more effective than imagery training. [Huang \(2005\)](#) also demonstrated that all types of creativity training have a positive impact on creativity across age levels and beyond school settings. However, a creative problem-solving training program had the least training time and yet the highest effects on creativity scores. [Yasin and Yunus \(2014\)](#) identified seven approaches to improving student creativity in the field of technology and engineering, including creative problem Solving/problem solving, computer/technology applications, inventive problem solving or TRIZ, integration of creativity lectures, case studies and creativity counseling approach, group plays for pre-school students, operational mechanisms of group composition approach and a group interactive brainstorming approach. They found that all these approaches had a positive effect on the development of creativity across educational levels.

The field of creativity often disagrees on the “criterion problem,” and the findings of the meta-analysis reflect variations related to the selected criteria. For example, [Cohn \(1985\)](#) found that creativity training improves creativity, as measured by fluency and originality. However, creativity training is not as effective in fostering creative performance on tasks that are different than those used during the training. Interestingly, the same increase in creativity can be produced by motivation or warm-up activities rather than an extensive training program.

[Scope \(1998\)](#) investigated the effect of instruction on creativity in school-aged children. The positive effects of instruction on creativity were consistent across subjects and treatments. However, independent practice as one of the instructional variables had a positive effect on creativity scores whereas other techniques, such as time dedicated to instruction, structuring, reviewing, questioning and responding did not have an effect. This finding seems to draw a line between “good instruction” and “instruction that supports creativity,” and although the latter may lead to the former, the former does not guarantee the latter.

[Kwon et al. \(2016\)](#) found that invention programs had positive effects on K-12 students’ creativity in South Korea and [Tsai \(2013\)](#) found that creativity training is effective for adults. [Moga et al. \(2000\)](#) analyzed the association between studying the arts and creative thinking and found that the link depends on the research designs and measurements of creativity. Correlational studies indicate moderate relationships between two variables, and the connection becomes clearer when the figural form is used to assess creativity.

“Can creativity be taught?” This is the most popular question on creativity and the meta-analyses seem to bring some good insights to this question. The answer is clear that creativity training often works, and there are strategies and techniques to enhance it.

Intelligence

The link between creativity and intelligence intrigues many researchers in the field. Early tests of intelligence included divergent thinking tasks (See “Divergent Thinking”) that are typically used for the measurement of creative potential. Some validation studies of creativity tests, such as the Torrance Tests of Creative Thinking (TTCT), include intelligence as a potentially related predictor of creative achievement. For those who believe that creativity is a distinct construct, intelligence tests serve as a criterion to test the discriminant validity of creativity tests ([Wallach and Kogan, 1965](#)). There are many studies that test the validity of the threshold hypothesis that underlines the varying nature of the relationship between creativity and intelligence at different levels of IQ. This is why [Kim’s \(2005\)](#) meta-analysis is noteworthy, in that it shows that the correlation between creativity and IQ is $r = 0.17$, and not significant. Moderator analyses indicate that the correlation is lowest when Wallach’s and Kogan’s tests were used as a measure of creativity. This finding is important in terms of the discriminant validity of creativity tests and seems to question cognitive models that view creativity as a sub-component of intelligence. It also highlights the possibility that untimed and lenient testing conditions yield better discriminant validity as a result of less reliance on the speed of processing and test anxiety. Another significant moderator is aging, which enhances the relationship between creativity and intelligence. This finding may explain why people get more creative with aging as a result of a greater use of memory and executive processes involved creativity. The small correlation between IQ and DT is expected because the creative thinking process involves both convergent and divergent thinking (see “Convergent Thinking”).

In a subsequent meta-analysis, [Kim \(2008\)](#) found that the correlation between IQ and creative achievement is lower than the correlation between DT and creative achievement. Creativity tests were a superior predictor of creative achievement than tests of intelligence; thus, this meta-analysis provided support for the predictive validity of creativity tests.

Achievement and Performance

Some studies focused on factors that may impact people’s academic or creative achievement as well as creative performance. Information technology is one of such factors. [Pacauskas et al. \(2017\)](#) focused on how information systems affect the creative performance of individual users. Their findings indicate that task-related challenges may foster creativity if the user is in a state of flow. This makes perfect sense from the perspective of the research on the intrinsic motivation for creativity, which is another

area of meta-analytic study (see below). The user-friendliness of an information system diminishes the cognitive load during its use, which can positively influence that user's creative performance (See Flow).

Another factor is the network structure of any group in an organizational context. Porter et al. (2018) analyzed 62 different samples and found superior creative achievement with open networks, which are characterized by weak ties, allowing exposure to novelty and diversity of information, compared to closed networks characterized by mutual support for members. Connectedness with the entire network is associated with better creative outcomes, whereas having direct ties is related to creative process behaviors. People are likely to connect to their immediate contacts when they need to engage in creative behavior, but the success of the final outcome still relies on the connectedness within the entire network.

The creative performance of employees is also influenced by a number of factors. Xu et al. (2017) conducted a meta-analysis and found that creative employee performance has the strongest association ($r > 0.50$) with team performance, cognitive reevaluation, team identity, concentration, and performance-approach goal orientation, followed by ($0.30 < r < 0.50$) for performance-avoidance goal orientation, feedback consistency, mastery-approach goal orientation, charismatic leadership, internal motivation, motivation for identification, working motivation, inhibition of expression, psychological satisfaction and time pressure. They saw moderate to weak relationships ($r < 0.30$) with positive and negative moods, autonomous and control orientation, the need for autonomy, executive support and capability and relationship requirements.

Academic achievement is another area of research interest. Gajda et al. (2017) focused on the relationship between academic achievement and creativity; and their study revealed a positive correlation ($r = 0.22$). However, this relationship depended on the types of measures of creativity and academic achievement. Verbal creativity tests yielded higher relationships with standardized test scores as opposed to grade point average. Interestingly, verbal creativity is a significant moderator in Kim's meta-analysis, too. The correlation between creativity and intelligence is smaller with verbal creativity tests compared to other tests of creativity. It is clear that meta-analyses on creativity should include test stimuli (verbal vs. non-verbal) as a potential moderator.

Recently, Elaldi and Batdı (2015) conducted a small meta-analysis to examine the impact of creativity-based learning on academic achievement, which turned out to be significant (Hedge's $d = 0.73$ to 1.56). This study needed to be small largely because empirical evidence on the impact of creative pedagogy is lacking, in spite of a great amount of reflective, theoretical and anecdotal reports and studies.

Motivation

Motivation is another interesting field of controversy in the area of creativity where meta-analyses can bring clarity. The central issue of debate is the role of intrinsic and extrinsic motivation. Jesus et al. (2011) borrowed Mel Rhodes' 4 P's framework (person, process, press, and product). They found that creativity related to the person was significantly associated with intrinsic motivation. The type of sample moderates this relationship: the relationship between the two variables was higher among employees compared to students. After a decade, Jesus et al. (2013) further examined the relationships between the two variables based on creative outcomes or products. They identified a positive relationship between intrinsic motivation and creativity as related to the product. Contrary to their previous meta-analysis, this study did not reveal any significant differences between students and employees. However, the association between the two constructs was moderated by the type of research. Namely, intrinsic motivation was stronger in regard to creativity in the cross-sectional studies compared to those in the causal comparative designs.

Liu et al. (2016) showed that intrinsic motivation, creative self-efficacy, and prosocial motivation have a unique power in predicting employees' creativity at work. They also have different functions in relation to contextual and personal factors behind creativity. Intrinsic motivation and creative self-efficacy have a more positive influence on creativity in individualistic cultures compared to collectivist cultures.

As an external motivator, rewards can influence creativity. Byron and Khazanchi (2012) investigated the effect of rewards on creativity. Their meta-analysis concluded that creativity-contingent rewards are effective in fostering creative performance. When feedback is positive, contingent, and task-focused on performance, it had a stronger association with creative performance. On the other hand, performance-contingent or completion-contingent rewards seem to have a small, negative effect on creativity. Therefore, the type of reward determines its influence on creativity.

Mood

Many studies on the impact of mood were meta-analyzed by Baas et al. (2008). They found that a positive mood led to more creativity than mood-neutral controls, but there seem to be no significant differences between positive and negative moods. Further detailed analyses indicated that a positive mood is activating, leading to motivation and a focus on promotion, which are more influential on creativity, as compared to avoidance motivation and a prevention focus. Davis' (2009) meta-analysis also supported the notion that a positive mood fosters creativity. However, the pattern of effect sizes demonstrated a curvilinear relationship between affective intensity and creative performance. This analysis shows that there are no benefits of negative moods for creative performance. As an example of negative moods, Byron and Khazanchi (2011) found that anxiety was negatively associated with creative performance. Specifically, trait anxiety had more detrimental effects on creative performance than state anxiety.

Personality

Meta-analytic studies indicated that personality traits are associated with creativity. Based on the Five-Factor Model dimensions, the meta-analytic studies (Karwowski and Lebuda, 2016; Puryear et al., 2017; Zare and Flinchbaugh, 2018) reported strong positive predictors such as openness, extraversion, and conscientiousness with openness was the clearest factor. However, this association also depended on the type of creativity assessment. The effect sizes were stronger when domain-general measures were used rather than domain-specific measures. Similarly, Puryear et al. (2017) found a stronger relationship with production (e.g., product development) rather than ideation (e.g., divergent thinking) and with self-reported measures compared to other-rated measures. Zare and Flinchbaugh (2018) also compared self-report ratings to other-report ratings that demonstrated a stronger relationship between openness and creativity; on the other hand, the source of the rating had no effect on the relationship between voice and the Big Five personality traits.

Feist (1998) found that creative people in the arts and sciences share personality profiles, including openness, conscientiousness, self-acceptance, hostility and impulsivity, regardless of the type of measure or taxonomy used to assess personality and creativity. These findings have implications for the mad-genius hypothesis, which are discussed later in the section on, “psychopathology.”

Neuroscience

Recently, meta-analytic studies have emerged in neuroscientific investigation of creativity with the help of brain imaging technology. Mihov et al. (2010) examined the brain’s hemispheric specialization and creativity, and found that the right hemisphere is dominant in creative thinking. A global thinking style, a context-dependent thinking style, and figural processes are significantly related to right hemisphere dominance. Using functional imaging studies, Gonen-Yaacovi et al. (2013) reached a different conclusion. They located some predominantly left-hemispheric regions (i.e., the caudal lateral prefrontal cortex, the medial and lateral rostral prefrontal cortex, and the inferior parietal and posterior temporal cortices) that share different creativity tasks. There was task-specific regional activation. For example, tasks involving the combination of remote information activate more of the anterior areas of the lateral prefrontal cortex than those involving unusual generation tasks. In general, some frontal and parieto-temporal regions seem to support cognitive processes during various creativity tasks in addition to others (See Neuroscience:fMRI).

Pidgeon et al. (2016) synthesized functional neuroimaging studies of visual creativity. Visual creativity produces significant activation in the thalamus, the left fusiform gyrus, and right middle and inferior frontal gyri. They also found a lower alpha during visual creativity. These conflicting findings are sometimes observed in meta-analytic studies, and a number of factors such as the scope of the study, research design, or analytic method may contribute to the inconsistency.

Psychopathology

Some meta-analysis studies resolve the controversy on creativity and the mental illness link, also known as the “mad-genius hypothesis.” Benham (2004) emphasized that the link between the two variables depends on how the psychopathology is measured. Studies using interviews, psycho-biographies and eminently creative subjects reported stronger relationships than objective measures with non-eminant participants. Therefore, the study design remarkably influenced the results. Paek et al. (2016) analyzed the relationship between common psychopathologies and everyday creativity. This analysis indicates that the link is weak overall and stronger among those with a high intelligence. This finding explains why the mad-genius hypothesis is more often found among eminently creative individuals rather than laypeople. It is possible that people with a high IQ and psychopathology may be more successful in channeling their potential into creative pursuits than others with a lower IQ.

Taylor (2017) found that the relationship between creativity and mood disorder depends on the research design. Creative people show a higher instance of mood disorder compared to noncreative people, but the creativity of people with a mood disorder and healthy people does not differ. The association is significantly higher in individuals with cyclothymic and unspecified bipolar disorders than in a unipolar disorder. Creativity measurements of accomplishment and behavior indicate significant relationships with a mood disorder (See Bipolar Mood Disorders).

As Benham (2004) suggested, the link between creativity and psychopathology varies across different levels and forms of psychopathology, which is why some researchers have used a more focused approach. Acar and Runco (2012), for example, examined the association of creativity with psychoticism and found that the overall relationship was small ($r = 0.16$). Another meta-analysis by Acar and Sen (2013) revealed even further differences within schizotypy. The association between creativity and schizotypy is not uniform, and the type of schizotypy has a significant impact on creativity. Namely, Positive-Impulsive and unspecified schizotypy are positively related to creativity ($r = 0.14$), whereas Negative-Disorganized schizotypy has a negative relationship ($r = -0.09$). A recent meta-analysis by Acar et al. (2018) shows that the relationship between creativity and schizophrenia is negative ($r = -0.32$), and the nature of the relationship is influenced by the way creativity is measured, the severity of the schizophrenia, the content of the creativity test and the patient type. The negative relationship is stronger when creativity is assessed with a semantic-category or verbal-letter fluency tasks rather than divergent thinking or associational measures among people with chronic schizophrenia as opposed to acute states and early onset levels. Studies with inpatients show significantly higher negative associations than outpatients. Acar et al. (2018) concluded that the relation between creativity psychoticism continua seems to demonstrate an inverted U shape, where sub-clinical levels may help creativity, while a strong or full demonstration of the symptoms diminishes it.

Byron et al. (2010) examined the relationships between stressors and creativity. Their study results suggested that the association depends on the level and type of stress induced. Low-level stress is associated with higher creative performance, whereas high levels decreased it. Uncontrollable stress decreases creative performance whereas the social-evaluative form did not. Also, low evaluative contexts improved creativity over control conditions, whereas highly evaluative contexts had a negative impact on creativity. Putting these together, there seems to be a curvilinear relationship between stress and creativity. This is the conclusion of studies conducted by Acar on the psychoticism-schizotypy-schizophrenia spectrum (See Schizotypy).

Problem-Solving

Creativity is a natural aspect of problem-solving. Ma (2009) conducted a comprehensive meta-analysis of all the variables associated with creativity and found that the strongest association with creativity is obtained from problem-solving tasks and verbal tests compared to emotional and nonverbal tests. Specifically, problem definition and knowledge retrieval are strong correlates.

In another meta-analysis by Abdulla et al. (2018), problem finding and creativity were significantly correlated. The relation is moderated by the various components of divergent thinking, the problem-finding domain and the participant's age. Specifically, the mean effect size was higher in fluency and on originality scores than on flexibility and composite scores; it is highest in the domain of writing and lowest in social studies and humanities. The highest was seen in grades 1 thru 6 and lowest in grades 7 through 12.

Others

Other published meta-analysis did not fit the above categories and hence are summarized here. Hunter et al. (2007) focused on *social and contextual influences* on creativity and found that situational factors such as support and autonomy are strongly related to creative performance, especially during challenging conditions such as high competition.

Lebuda et al. (2016) synthesized the relationship between *mindfulness* and creativity. Mindfulness has been found to be significantly related to creativity, but the relationship is weak ($r = 0.22$). The type of mindfulness moderates the associations between the two constructs. The open-monitoring aspect of mindfulness has a higher correlation than the awareness aspect of it.

Gender differences in creativity is another area of interest in the literature. Thompson (2016) showed that females show slightly higher creativity than males. The creativity construct and the type of creativity test moderate the relationship between creativity and gender. Differences are larger in DT tasks than others and in creative achievement rather than ability.

Said-Metwaly et al. (2018) examined the factor structure of the *Figural Torrance Tests of Creative Thinking* (Figural TTCT) by testing four factor models previously presented in the literature. Their results suggest that a two-factor structure model fits the data best. Fluency and originality subscales come under the "innovative" factor; elaboration, the abstractness of titles and resistance to premature closure subscales, is loaded under the "adaptive" factor.

Haase et al. (2018) investigated the relations between creative *self-efficacy* and creativity measures. Their study revealed a medium effect size correlation between two constructs ($r = 0.39$). Self-rated measurements have higher relationships with self-efficacy than with divergent thinking. The personal aspect of creativity seems to be most strongly related to self-efficacy, compared to the creative product and the creative process.

Conclusion

Creativity research is growing fast, as have meta-analytic studies on creativity. Some topics often revisited are the impact of creativity, the mad-genius hypothesis, and the role of personality, motivation and mood. There are two major reasons for this. First, there is more controversy surrounding these topics and meta-analyses are useful to bringing some clarity. Meta-analyses have reported linear effects such as a positive relationship between creativity and intelligence, openness, extraversion, intrinsic motivation and positive effects, as well some non-linear effects such as psychopathology. Second, a meta-analysis cannot be done when there are not a sufficient number of quantitative studies. That said, more meta-analyses should be expected in the future as new areas are explored by researchers.

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Metacognition

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Definition: Then and Now

Although this entry regards metacognition, due to the strong theoretical and empirical tie between metacognition and motivation, a limited number of reviews on motivation is included in places to provide a better sense of the context of this entry. As learner engagement in metacognitive activity is largely hinged on learner motivation to participate in such activity, this section begins with self-regulation as the construct is related to both metacognition and motivation.

Metacognition is a component of manifested self-regulated learning postulated within the social-cognitive theoretical framework (Zimmerman, 2000). Self-regulated learning is derived from earlier work by Flavell (1979). Flavell defined metacognition in areas including metacognitive knowledge, metacognitive experience, activation of strategies, and goals. Metacognition was then separated into 'knowledge about cognition' and 'regulation of cognition.' Metacognitive knowledge indicates awareness of one's own declarative, procedural, and conditional knowledge and strategies. Metacognitive regulation involves planning, monitoring, evaluating cognitive operations, and selecting and using cognitive strategies effectively by combining, discarding, and coordinating various strategies.

From this distinction, 'regulation' of cognition expanded into contemporary self-regulation that includes motivation in the model. This addition signifies the close relation between metacognitive and motivational aspects of self-regulation in the learning and problem solving process. In this formulation, self-regulated learners are described as highly motivated as they view tasks as useful, important, or interesting, are self-efficacious, and monitor and regulate their efforts and perseverance during tasks; further, self-regulated learners are aware of their own knowledge, strategies, and thinking process and regulate the use of metacognitive strategies during tasks.

While acknowledging metacognitive processes as fundamentally important human cognition for creativity and problem solving, Sternberg's (2001) description of 'creativity as a decision' supports the notion that motivation is a driving force for creativity and that metacognition helps maneuver creative process. As such, in studying the relation between metacognition and creativity, including motivation as a variable, along with other related variables, will help better understand the nature of the relation between metacognition and creativity. Construct validation studies for self-regulation and its subcomponents, metacognition and motivation, have provided support to its structural validity on both state and trait constructs.

Diverse definitions and measures have been used in studies of metacognition as well as creativity, posing challenges in drawing conclusions and finding meanings about the relation of metacognition to creativity. The frequently quoted general definitions of metacognition (e.g., thinking about one's own thinking or cognition about cognition) does not convey what particular researchers might mean about metacognition, and this constitutes a cautionary note for research consumers, as the disparate uses of the term metacognition continue to the present day.

Relations of Metacognition With Learning, Motivation, Mind Wandering, and Creativity

To provide context for discussing the relation of metacognition with creativity, relations of metacognition with learning, motivation, and mind wandering are reviewed first, followed by its relation with creativity. Although learning, motivation, mind

wandering, and creativity are interrelated among each other and with metacognition, they are separately addressed to place an emphasis on each.

Metacognition and Learning

Metacognitive abilities have been noted as positively related to learning, as effective uses of metacognitive strategies have been documented as having a significant role in academic achievement. However, a nonsignificant relation has also been reported in several studies. This relation varies across grade levels, showing the effects of learning environment and other related variables that come with school aged children on metacognitive skill uses. For example, the metacognition-learning relation in a study demonstrated that the relation was significant in middle school students, but not in high school students.

Metacognition plays a central role when solving open-ended problems. Although experts may possess superior metacognitive skills than do novices, experts do not necessarily make more metacognitive statements than do novices. This phenomenon may occur because experts' metacognitive skills have been proceduralized. The automatic processing or proceduralization of expert skills should not be confounded with cognitive processing of learners who lack explicit awareness of what they are engaged in. An individual who can solve complex problems but is unable to explain how he or she found a solution could be a person who may or may not be highly metacognitive.

Metacognition and Motivation

In self-regulated learning models, metacognitive regulation processes are pervasive. Equally pervasive are motivation sources (e.g., self-efficacy, persistency, autonomy, value, interest) as metacognitive regulation applied by the learner is largely dependent on whether they are motivated to regulate their cognitive processes. Similar to metacognition, motivation is a complex psychological phenomenon with no one principal overarching theory or definition. In the past few decades, theories such as social-cognitive theory, self-determination theory, and expectancy-value theory have been advanced, some of which offered variables that have demonstrated close relations with metacognition. Students' motivation level and metacognitive strategy use have been shown to be positively related in various studies.

The essential role of motivation in the creative process has been emphasized by a number of researchers. (See Motivation) [Hong et al. \(2009\)](#) distinguished intrinsic motivation into two different manifested motivations—favoring and enjoying 'challenging work' versus 'creative work,' with the distinction supported by factor analysis. When the two types of intrinsic motivation were included in a path model for testing their effects on creative performance, only intrinsic motivation for creative work demonstrated a positive relation with creative performance ([Hong et al., 2016](#)). Types of thinkers (analytical vs. creative thinkers) might have been a factor in this finding. Individuals motivated by challenging and difficult work tend not to engage themselves in creative thinking that allows them to produce divergent and original solutions, possibly because they are more analytical than creative thinkers. This distinction was also demonstrated in a study that examined teachers' classroom practice; teachers with high intrinsic motivation for creative work reported practicing more creativity-fostering instructions as compared to teachers with high intrinsic motivation for challenging work ([Hong et al., 2009](#)). Different patterns of alpha activities were shown in the brain for convergent versus divergent types of responses, supporting different brain processing for creativity-related versus non-creativity-related performance. Thinking styles might have impacts on the use of metacognitive abilities and motivational attention, an area which requires more research to unravel the relations among these variables.

Metacognition and Mind Wandering

In recent years 'mind wandering' surfaced as a construct for investigations in its relation to metacognition. [Smallwood and Schooler \(2015\)](#) described mind wandering as a dynamic and fluid conscious experience from a current task to unrelated thoughts and feelings, suggesting the importance of its association with metacognition for determining functional outcomes of mind wandering. In pursuit of how metacognitive awareness and the control of mind wandering occurs, researchers reasoned from various brain studies indicating that metacognitive monitoring process might help catch and regulate one's mind wandering and may minimize the downsides of mind wandering while maintaining its productive aspects. What has not been discussed is if mind wandering would occur for those who built a habit of metacognitive processing, controlling their learning or creative process, and if there would be any negative effects with applying metacognition at all times during learning and creative process.

Mind wandering seems to increase metacognitive awareness when performing a task. [Allen et al. \(2013\)](#), in examining the default mode network (DMN), a large-scale network focused on the medial prefrontal cortex and the posterior cingulate cortex, and the network that supports decontextualized cognition, found greater metacognitive awareness of the errors committed during the task, suggesting that mind wandering and self-monitoring are intertwined. Whereas turning attention outward with high working memory capacity facilitates analytical problem solving, creative and original solutions can be challenged or weakened with excessive outwardly focused attention. Relatedly, inwardly focused attention for examining one's thoughts facilitates new and creative solutions to problems ([Wiley and Jarosz, 2012](#)) (see Breadth of Attention).

Metacognition and Creativity

Metacognition has long been associated with creativity (Feldhusen, 1995), suggesting that creative-thinking skills operate in concert with self-monitoring and self-evaluation to sustain creative thinking. Whereas some empirical research supported this relation, this view has not been consistently supported in other studies. Some of the research studies that demonstrated positive effects of metacognition on creativity are presented below followed by those indicating no effects.

Metacognition and Creativity: Positive Relations

Metacognitive process and its positive association with creative problem solving or creating novel products have been reported. The role of expertise in the relation of metacognition with creativity has been discussed in terms of self-regulatory process (Steele et al., 2017). Steele et al. contended that exploratory regulatory processes are critical during the initial stage of creative performance, especially at the problem finding stage, by reasoning that expertise facilitates creativity as experts have well organized deep domain relevant knowledge. That expert's knowledge of subjects and context and their experience play an important role in the activation of metacognitive process was supported in research. For example, artists, as compared to non-artists, engaged in more metacognitive activities during the creative process, although there was no difference in metacognitive evaluation between artists and non-artists as participants in both groups self-evaluated their work throughout.

It is worth noting that the type of school moderated the effect of metacognition on creative problem solving (Preiss et al., 2016), with the significant effects of metacognition on creativity showing in university students but not in vocational college students. Perhaps university students were more equipped with knowledge relevant to the research topics and tasks than were those from vocational college. Additional investigations on age and the type and level of education of research participants and other qualifying variables will further clarify the dynamics of the relation between metacognition and creativity.

Stressing that measures of creative potential (ideation) should be distinct from those of creative products, Puryear (2015) tested the role of metacognition as a moderator for the relation between creative ideation and creative production. In comparing the major components of metacognition (knowledge of cognition and regulation of cognition), Puryear found knowledge of cognition showing a stronger moderating effect than regulation of cognition, to which Flavell's (1979) emphasis on the knowledge component of metacognition was referred. Within the knowledge component, declarative knowledge (knowledge of self, resources, and ability) was the strongest moderator.

Metacognition and Creativity: No Relations

Effects of metacognitive skill use on creativity have not been consistent. Nonsignificant effects of metacognitive skills have been shown especially when other relevant variables are included in research studies. In Preiss et al. research (2016) regarding the effects of metacognition and mind wandering on creativity, other variables such as fluid intelligence, reading difficulties, and type of school were included to control their effects on the relation of metacognition and mind wandering to creativity. Metacognition did not significantly predict creative performance measured by creative solutions generated in divergent thinking and problem solving. Instead, mind wandering predicted both creativity outcomes. Some of these results were explained by Fox and Christoff's (2014) proposition that separates the creative process into 'generative' and 'evaluative' process. Fox and Christoff postulated that creative generation is largely based on spontaneous thought process, whereas creative evaluation involves metacognitive engagement. Steele et al. (2017) also suggested similarly that metacognitive activities might occur more often during optimizing creative performance. That is, when participants are evaluating creative solutions, rather than when generating them, metacognitive activities occur more frequently, a theory that still requires more validation.

In a similar vein, Hong et al. (2016) found deliberate metacognitive processes reported by research participants did not have an effect on creative performance. The results of structural equation modeling demonstrated that when the effects of trait metacognition and correlations among trait motivation and trait metacognition were controlled, state metacognitive activities did not show effects on creative performance. In addition, creativity measures may explain this finding further, as creative activities in this study required generative process that may not necessarily recruit metacognitive skills in the process.

In another study either of the two indicators of metacognition (knowledge of cognition and regulation of cognition) did not predict mathematical creative ability when the effects of openness to experience, intrinsic motivation, and one of the two indicators of metacognitive tendency in turn were partialled out. Variables that predicted mathematical creativity were intrinsic motivation and openness to experience, demonstrating the impacts of motivation and personality on creative performance beyond metacognition. These studies point to the importance of including relevant related variables and understanding of the type of creativity measures when examining the relation of metacognition with creative performance.

Summary

Fox and Christoff's (2014) descriptions of mind wandering (undirected and spontaneous thought processes) and metacognition (conscious, intentional regulation of thought processes) seem to suggest that the two constructs are opposite in their meaning and functions. As they describe how the first appearance of distinct differences becomes a dynamic interplay between the two seemingly different constructs, it challenges the common and simplistic view that metacognition and creativity are linked. Fox and

Christoff not only made the distinction between creative generation and creative evaluation (called also metacognitive evaluation) but suggested that a temporal separation between the two (i.e., sequential engagement of creative generation and creative evaluation) increases creativity of the outcomes. Further, deducing from the analysis of neural correlates of creative evaluation and creative generation, they contended that metacognitive evaluation may facilitate future creative generation efforts to produce novel and useful ideas identified while engaged in previous metacognitive evaluation phases.

Depending on the type of creativity of interest, metacognition may be best employed at different stages of the creative process (Steele et al., 2017). For example, for incremental or expected creativity, metacognitive activity should be high at the outset. On the contrary, when radical or highly novel creativity is sought, metacognition should be delayed at the outset, as radical creativity is usually linked to the combining of disparate areas of knowledge.

Essential to remind us—the researcher (knowledge makers) and the reader (knowledge consumers)—is that the direction and size of the relation may change depending on what other related variables are included in each research and how they are presented and measured in designing research, among others. Whether creative endeavors turn out as success or failure depends on a complex system of human cognition, motivation, and other variables such as personality and environmental factors. Overall, as the empirical relation between metacognition and creativity has not been strongly established, continued research is needed.

Metacognitive Instruction

Provided in this section are discussions of (a) explicit instructions and programs for teaching metacognition and (b) effects of metacognitive instructions on creativity.

Explicit Instructions and Programs for Teaching Metacognition

Trainability of metacognitive skills in relation to the development of creative thinking abilities has been discussed. For students to develop metacognitive abilities, students need to be given opportunities to learn and practice the skills. Teachers of young children to college students have an important role in providing learning environments that help students accumulate metacognitive knowledge and activate metacognitive regulation. To be able to create such climates, teachers need to be equipped with deep understanding of what metacognition entails. Increasing teachers' own metacognitive knowledge and developing metacognitive skills through numerous metacognitive experiences are essential steps to achieve the status where they can help students learn to be metacognitive in learning and creative process. Having knowledge of cognitive, metacognitive, and motivational strategies as well as experiences in regulating knowledge and strategy applications would be valuable in preparation for teaching their own students especially for solving complex and ill-structured problems and for being creative in such problem solving endeavors.

Intervention Programs: The Need for Encouraging Learning Environment

Beyond increasing knowledge of strategies, learners need to engage in the regulating process, planning, monitoring, and evaluating their own learning and problem solving process, and receiving feedback that allow for making corrections and adjustments. Explicit instructions and learning opportunities help learners reflect on the metacognitive knowledge they have gained and practice metacognitive skills they have learned, and gradually develop their own template or model that they can apply in various situations. Important in this process is that this type of learning may not occur in the absence of formal and informal teaching and training. A few examples of intervention programs are provided below.

Hu et al. (2013) provided students with opportunities to practice monitoring their own thinking in an intervention program for increasing scientific creativity. The program makes the teaching of metacognitive skills explicit through an organized procedure in which the teacher initially makes metacognitive strategies explicit and helps learners internalize the strategies with a goal to establish the strategies eventually become part of the learners' habitual mode of thinking. In this intervention each learning activity comes with a chance for students to summarize and reflect on their own thinking strategies, problem finding and solving methods, and on what was learned from their learning activities, with the intention that students will apply and transfer what they learned to other domains.

A supplemental course was used for teaching creative thinking strategies within a metacognitive framework (Hargrove and Nietfeld, 2015). Metacognitive skill development was fostered each week by integrating a new creative thinking strategy with metacognitive activities. Although this type of course at the university level may not be easy to implement because of limitations including scheduling and coordinating courses, it is feasible as long as creative and dedicated instructors are willing to make it happen. Existing courses can serve as good environments for teaching and learning and experiencing metacognitive skill use. From students of a very young age to adult learners, modeling metacognitive behavior can be a useful strategy. Teachers can think-aloud their own metacognitive process during problem solving by creating teachable moments where certain strategies can be used for monitoring and evaluating processes. The modeling must be followed up with an abundance of practice opportunities for learners to plan, solve, monitor, and evaluate, and repeat as needed with diverse problem situations over time.

Scaffolding is another way to help students learn metacognitive skills. Utilized in a program that used prompts for college freshmen's project-based community service learning, participating students were told to find innovative solutions to the problems they identified on site. In the process, students learned to use metacognitive strategies as well as creative problem solving strategies.

Students' learning of strategies was facilitated with a designed intervention, mainly utilizing email question-prompts that guided students to the end of projects. Likewise, instructors can help students enhance self-monitoring and self-facilitation by stating expectations that prompts and promote learner responsibility. Based on the benefits of active learning grounded in constructivist perspectives with a postulation that learners are in control of their own learning and are active processors of content, scaffolding built with the assumption of learner responsibility and management for their own learning process will likely help them develop metacognitive abilities and improve learning experience and performance.

Effects of Metacognitive Instructions on Creativity

Numerous articles, some theoretical along with a small number of empirical studies, underlined the importance of metacognition in learning and creativity activities, albeit not all research studies back the claim. Although creating learning environments to help students develop explicit metacognitive schema ready to be utilized for metacognitive practices has some support in literature, it is prudent to remember that such an endeavor building an instructional system requires the scrutiny of further research. The following includes research that has examined whether explicit instruction is effective in increasing creative performance.

Based on the understanding that frontal lobes maturation continues into early adulthood and the maturation is not yet consolidated in undergraduate students, [Reyes-Meza et al. \(2015\)](#) examined whether changes might occur in brain regions when students participate in activities that require them to use executive functions to promote their maturation. In an applied creativity course, students were asked to develop innovative proposals and present original solutions to problems by applying creativity concepts and techniques to significantly transform their environment. After the course work, changes to the anterior prefrontal area (PFAC) associated with an increment on executive functions were observed in some students. The changes regarded metacognitive judgment, metacognitive monitoring, and metacognitive control (the ability to develop a memory strategy). These changes were attributed to activities during the course that integrated exercises to increase the competence of autonomy and promoted self-evaluation of their own abilities at setting tasks to reach goals, thus generating functional modifications on the PFAC.

How explicit instructions can make a difference in creativity has also been studied by brain cerebral blood flow (CBF) examination. Whereas fluency and flexibility were strongly correlated with CBF in the left inferior frontal gyrus, originality was correlated with CBF in the left superior temporal gyrus and cerebellar tonsil, indicating that when the responders set their goals based on the test instruction, their processes of creative performance tapped different neural networks to meet the demand of the instruction.

Hargrove and his colleague conducted research studies to examine the effect of deliberate metacognitive instruction on metacognitive development and on creativity in design education. [Hargrove and Nietfeld \(2015\)](#) posited that through metacognitive reflection, designers progressively build more formal theories that allows for intentional attempts to apply their creative thinking skills to design applications. Their research approach included encouraging participants, undergraduate students in a design course, over a 16-week period, to develop metacognitive skills to generate creative solutions to design-based problems. A new creative-thinking strategy was introduced each week with a specific purpose to help student develop metacognitive ability. The research results supported their postulations with the treatment group showing metacognitive awareness scores increasing over a course while the comparison group stayed stable. Students in the treatment condition also showed higher creativity scores compared to their counterparts in the comparison group (see Teaching Creativity).

Research on metacognition and creativity has been steadily growing in various fields, primarily investigating the relation of metacognitive ability with creative process and outcomes and building instructional models for application of metacognition in specific disciplines. The fields that have shown interest and made progress in understanding and applying metacognition in teaching, learning, and product outcomes include mathematics, science, secondary language, technology, engineering, information systems and management, nursing, various areas of design education, and military personnel training. Cultural metacognition—cultural consciousness and awareness during social interaction—has been a topic of interest in situations where multicultural team work is required.

Conclusion

Although a great deal of understanding of metacognition has been generated, research results suffered from incongruencies in the use of the construct and its application among various fields. In the quest toward deeper comprehension of metacognition in creativity, creativity researchers may need to approach the construct in a more reflective way. In particular, when metacognition can be seen as imposing rigidity (attention turned outward utilizing a high level of working memory), it may be important to consider how such a deliberate thinking process may use up mental space when space for spontaneous thinking is needed (attention turned inward facilitating creative processing).

Some studies demonstrated a positive association between metacognition and creativity; however, many seemed to lack rigor. In light of numerous studies that examined the relationship between creativity and other constructs such as personality, the field needs more studies on the personality-metacognitive interaction to shed more light on how metacognition affects creativity when personality is included in research. Similarly, the association between motivation and creativity has been well studied, and including motivation in research to isolate the effect of metacognition on creativity beyond the influence of motivation may produce more accurate information. For example, could strong interest and unforced metacognitive regulation result in spontaneous creative activity more so than with weak interest? How metacognitive process is applied to creativity tasks by individuals with certain motivational

tendencies, with certain personalities, with certain thinking styles, and with certain types of instructions is an area where more research is needed.

Application of metacognition also depends on the type of research problems or task nature. Whereas certain tasks may be more motivation- or personality-dependent, others may require metacognitive process at the beginning, middle, or end part of the task completion. The studies of mind wandering seem to have opened up an area in which researchers can explore when, for whom, and for what occasions or tasks, the transition from drifting mind to metacognitive mind can be encouraged to foster creativity. This is yet another challenging but worthwhile research area.

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Meta-Creativity

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Glossary

Intentionality Making a conscious decision to do something, as is the case when a person consciously decided to question assumptions or shift perspectives.

Meta-art Art which allows the artist and the audience to question the function of art.

Meta-cognition Thinking about thinking.

Meta-creativity The application of what is learned from studies of creativity to the subsequent research on and thinking about creativity.

This *Encyclopedia of Creativity* attests to the progress that has been made over the past few years towards a deeper understanding of creativity. This is the third edition and progress is apparent in the various updates to chapters which were covered in the two previous editions. Progress is probably even clearer in the new topics in this third edition. Many of these focus on technology and creativity, and quite a few focus on the neurosciences and creativity.

The progress is especially impressive because creativity is not an easy subject matter. No wonder Frank Barron, one of the key figures when this field was just starting out, wrote in his last book, *No Rootless Flower*, that to measure creativity (and thus do empirical research on it), some creativity was required. Creativity is a challenge because some of it is unconscious, personal, emotional, and not easy to investigate with methods that work in other fields and work with other topics. Paraphrasing but also broadening Barron's idea, to study creativity requires creativity.

One advantage now available is *meta-creativity*. This may sound like jargon or a buzz word, but the label really is perfectly apt. Consider other uses of the prefix meta. There are meta-analyses, which analyze the results from previous analyses, and there is meta-memory, which is one's memory for what and how one remembers. Meta-cognition is thinking about thinking. Perhaps closest to the current topic are the terms *meta-art*, *meta-drama*, and *meta-theater*. These refer to art that somehow asks the viewer or audience to think about the function of art. Joni Mitchell wrote a song describing how singing is a unique art form (that is, she sang a song about singing), and in the visual arts Warhol's work comes to mind. Shakespeare sometimes had *dramatis personae* in dialogue about actors and acting. Marcel Duchamp was quite explicit about meta-art. He claimed that "The spectator makes the picture" (quoted from the University of California Press <https://publishing.cdlib.org/ucpressebooks/view?docId=ft3w1005ft&chunk.id=d0e6221&toc.id=&brand=ucpress>, downloaded 22 August 2019). The idea of art eliciting reactions, not about the subject matter, but instead about the nature and function of art, is frequently traced to Immanuel Kant's *Kritik der Urteilskraft* [*Critique of Judgment*], and in particular his idea of a *Transcendental Aesthetic*. Schinckus (2019) offers a new look at the philosophy behind this perspective on art and explains how Henri Bergson was also instrumental in developing it.

Meta-creativity is an apt label for *the application of what is learned from studies of creativity to the subsequent study of creativity*. There are clear benefits to meta-creativity and it may be responsible for some of the recent progress in the field of creativity studies. This chapter explores several examples of meta-creativity.

The term meta-creativity was used in the *Journal of Creative Behavior* in 1998, but it had a different meaning from how it is used here. Bruch (1988) used the term meta-creativity but defined it as focused on "internal observations of creative processing and personal characteristics... [that] constitute a new field" (p. 112). That definition might apply specifically to an individual's thinking about his or her own creativity, which is not far from meta-cognition and meta-memory, and it might fit with psychodynamic or humanistic views of how creativity is related to health. This previous usage of the term meta-creativity is clearly different from how it is used here. The earlier usage was concerned with individual and internal processes and the newer usage explored in this entry is about creative methods which are based on what is learned from creativity research and then applied to creativity research in the future.

Meta-Creative Techniques

One of the clearest examples of meta-creativity involves the questioning of assumptions. This is a widely used tactic and has been recommended by numerous researchers and observers. The questioning of assumptions seems to have led to many creative

breakthroughs (e.g., [Root-Bernstein, 1989](#)), so it is wise for creativity researchers to use the tactic themselves. One way of describing the benefit of questioning assumptions is that it opens new doors, suggests new perspectives, and highlights things which were taken for granted in the assumptions. Taking things for granted is often a barrier to creative insights, as are the related barriers involving habits and routines. It may be that the notorious “cost of expertise,” where individuals with large knowledge bases overlook original possibilities, can be explained at least in part by their making assumptions. This is a good example in that it both points to a benefit of questioning assumptions but also relates them to experience and expertise. In addition this example makes it clear that assumptions are not all bad. Experts make assumptions based on knowledge and, for that reason, can process information very quickly. Sometimes the information processing is automatized and details are not considered, which is why the information processing is so efficient. The point is that there are often pros and cons to assumptions. One recommendation from this line of thought is that it may be that tactics and assumptions are useful, but only if the individual is aware that he or she is using them. Intentionality may be very important, if not vital. That actually fits well with many definitions of creativity; many of them recognize the important role of intentions.

Specific Examples of the benefits of questioning assumptions are easy to find. Einstein apparently questioned the Newtonian assumption of absolutes, and the Impressionists questioned the need for realism. Then there are examples from the field of creativity, which is the primary concern of this chapter—being creative about creativity research. The idea of a *creativity complex* can be given as an example, though at first it was an observation based on research results and actively discussed in the research. Donald MacKinnon described creativity as a syndrome, for example, as did [Mumford and Gustafsson \(1988\)](#). The evidence for a syndrome or creativity complex continued to accumulate, the key being that creative performances seem to rely on contributions from cognition, personality, attitude, affect, and perhaps style. At this point the idea of a creativity complex is rarely if ever tested; it operates as an assumption within the creativity research. Yet the meta-creative approach suggests that this assumption should be questioned, which is what the theory of parsimonious creativity is all about. It questions the idea of a complex and follows a logic where all results of the creative process are put aside precisely because they are results of the process and not involved in the processing—what might be called the actual creation. It also relegates mere influences on the creative mechanism, which means that things like cognitive style are put aside. Certainly cognitive styles can influence the actual creation but there are different ways to be creative. No one style is required of all creativity; and in that sense no style is always involved and vital. This approach, which puts (1) results of the creative process and (2) mere influences on the creative mechanism aside, eliminates many things that are usually included in the creative complex. Hence the label, parsimonious creativity. The intent is to simplify and isolate the actual explanatory mechanism that is involved in all creativity. Other details about this view are presented elsewhere in this volume.

Although intentions were mentioned above it is possible that some meta-creativity occurs without much effort. Consider the meta-creative tactic *change perspective*. This is a quite general tactic and may include putting a problem aside for a time and allowing incubation, talking to other people, collecting more information, taking a walk and looking for analogies, or physically changing one’s point of view, as implied by suggestions to zoom in or zoom out, turn the problem on its head, and so on. Many shifts of perspective lead to changes in one’s thinking, and originality may result. As for intentions, note the idea of collecting more information. This is what researchers do when they read other research or collect data; and very likely they also change their thinking as the new information comes in. Thus a new perspective may result from just going through the scientific method. Researchers may not stand back and say “I need to change my perspective” but instead just collect new information and their perspective changes without it being a conscious decision.

Much the same may be said about the tactics that were described by Sidney Parnes, and in particular what he called “let it happen” tactics. These are things people may do to get out ruts, routines, and fixed perspectives. Talking a walk or incubating are two good examples. The person does not impose some problem solving technique but instead gets out of one context and thus relaxes and perhaps broadens associative processes. This kind of thing can be contrasted with what Parnes call “make it happen” tactics. These are more intentional, more effortful, more dependent on particular decisions. Both let it happen and make it happen tactics have been shown to benefit creative thinking, and both could be used meta-creatively by individuals who are studying creativity.

Then there is mindfulness. It too has been supported by creativity research. Ellen Langer has published a series of reports in the *Creativity Research Journal*, and elsewhere, and much of the work is summarized in her book *Mindfulness* from 1989. The general concept of mindfulness is quite relevant to the argument presented here about meta-creativity in that both indicate that it is a good thing to monitor one’s own thinking and to be consciously aware of decisions being made, especially when they influence one’s thinking. Too often assumptions are made mindlessly and they constrain one’s thinking and keep it from being original, fresh, and creative. What is most relevant is probably the idea from Langer’s work on mindfulness that people have a tendency to categorize information. This is natural and often helps structure thinking and experience so searches are efficient; but there is a downside, at least when previous categories of thought are used in new situations and new information is ignored because it does not fit into old categories.

This is enormously helpful when thinking about meta-creativity. Consider the idea of Big C and little c creativity. [Merriotsy \(2013\)](#) reviewed that dichotomy and concluded that it might have been borrowed from studies of culture (where Big C and little c refer to different kinds of cultures)—and thus might not be a good fit for creativity research. Regardless of its origins, it is a dichotomy, and dichotomies can be misleading. After all, reality is complicated. All categorizations are simplifications, and the simplest (and therefore the kind of categorization that ignores the most information) is the dichotomy. The problem with

the Big C/little c dichotomy is that it implies that they are entirely different from one another when in fact the latter may very well be necessary for the former. It may be that an individual must have an original idea, and at first it is a private event. That idea might later be shared, refined, extended, and tested, and sometimes this leads to a major breakthrough. It is not as if eminent creators have one kind of brain that allows one kind of thinking and everyday creators have another kind of brain and another kind of thinking. Certainly eminent creators may be experts, but that means they have mastered a field and are well-informed. They may also be persistent, especially when intrinsically motivated, but that means they are motivated and persistent, not that the kind of thinking used differs from that which allows the rest of us from having an original and effective idea.

The main problem with the Big C/little c dichotomy is that there are gradations of creativity, and variations. Eminent creators may have one major breakthrough and most everything else is only creative in an everyday or mundane fashion. The standards used to classify creativity may vary from world class to entirely local or even personal. Consider the author who writes something but does not share it. It could be original and effective in the sense of capturing that person's thoughts and emotions. Maybe it is shared and one other person sees the creativity. Or perhaps it wins an award at some university. Or is published. Or wins a Pulitzer. Or changes the domain. There are similar gradations in all fields and any one dichotomy is a simplification.

The research on mindfulness suggests that we should remain aware of the categories we use and modify them as new information makes itself known. In the case of research this should be changed to "new information is discovered." The point, however, is to be mindful and recognize the changing and complicated nature of reality. That certainly applies to the topic of creativity and applies to creativity research. As evidence consider the Big C/little c dichotomy that may have been borrowed from research on culture (Merrotsoy, 2013), and gradually became a staple in studies of creativity. Only recently was identified as a false dichotomy. Thus being mindful of categories beyond a dichotomy advanced the creativity research.

One last example of metacreative thinking is suggested by another chapter in this same *Encyclopedia*. This other chapter focuses on the *magic synthesis*. The original conception of the magic synthesis described it as the process whereby primary and secondary processes collaborate, the result being creative. The main point of that chapter was that there are various ways in which creative thinking benefits from syntheses and even paradoxes. The collaboration of primary and secondary processes represents one example of a fruitful synthesis, but there are many others, each of which allows a juxtaposition of opposites or contradictions. The Janusian process is another example [see JANUSIAN, this volume] of cognitive syntheses, but paradoxes are resolved in a creative in personality as well. This occurs when creative individuals express seemingly contradictory traits. They may be both masculine and feminine, for example, or both introverted and extraverted. This has been called the paradoxical personality.

It may be that the capacity to synthesize paradoxes, contradictions, and opposites is tied to the same process which is associated with mindfulness. After all, mindfulness leads the individual to avoid exclusive thinking and to remain open to possibilities that would be precluded by thinking with strict dichotomies and categories.

Importantly, some time ago Frank Barron observed that creative individuals are notably tolerant of contradictions and paradoxes. In fact he described how creative individuals sometimes seek out contradictions and paradoxes because they know that thinking about them often leads to a creative insights. This is why the magic synthesis is included in the list of metacreative options: it can be utilized. Those studying creativity can choose to examine contradictions and paradoxes and in that way find creative ideas.

Conclusions

This entry to the Encyclopedia defines meta-creativity and points to various examples of it. These include changing perspectives, being mindful of dichotomies and categorizations, questioning assumptions, and keeping one's eyes open for paradoxes. This is a tentative list. Other meta-creative tactics may already be in use, but perhaps not named meta-creative, and still others may later be identified, developed, and refined. Admittedly in some cases the benefits of meta-creativity for research are quite clear (e.g., moving beyond the false dichotomy of Big C/little c), but the thesis of this entry does not imply that the creativity research is only advancing because of meta-creative tactics, including those listed above. These meta-creative tactics may be viewed as one option in the research toolbox and one of several reasons why research is advancing.

One possible meta-creative possibility was not discussed above. It involves intrinsic motivation. It was not mentioned earlier, when questioning assumptions and the other metacreative tactics were reviewed, because there is no real recommendation when it comes to intrinsic motivation, other than take advantage of it when it arises. Intrinsic motivation is often associated with creative thinking and with the persistence that characterizes highly creative individuals. It is also associated with the everyday thinking that is involved in personal creativity. This kind of motivation is intrinsic; it is not something that the individual decides to do. People find what is intrinsically motivating. There may be no choice in the matter, in which case the only recommendation is to be aware that what is intrinsically motivating, like paradoxes and contradictions, may lead directly to creative thinking and insights. Creativity is so valuable, in so many different ways! People should invest in it, support and appreciate it, find tactics to facilitate it. Similarly, now that the field of creativity research has established itself and there is a body of research findings, those studying creativity should stand back and use what has been learned specifically to insure that creativity research is itself creative.

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Metaphor

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Metaphor as a Means to Knowledge

The use of metaphor amounts to explaining the unknown in terms of what we know. This means of gaining knowledge ignores literalism and is often an invaluable resource to understanding certain areas of reality. Such is the case of Boyd's 'constitutive metaphors' in science, in which the construct (stem cells, or the selfish gene theory, for example) cannot be understood but through a powerful metaphor.

However, without reaching such complex epistemological heights, the importance of metaphor in human thinking and discourse is rooted in the extensive use we make of it from an early age, and the presence of so many more or less abstract ideas that we express through metaphor, across a great number of languages and cultures. This is what Lakoff referred to as 'conceptual metaphors': for instance, seeing life as a journey.

To express this concept for everyone to understand, these four words will suffice: "this is like this". Children and adults alike use this fertile mental resource for combining two terms to explain the unknown in terms of what we do know, either through set phrases (to fly like an arrow or as high as the moon) or from our own experience and prior knowledge, matching something familiar to the thing we are trying to explain. In a poetic vein, our forebears gave names to the constellations to establish their positions in the night sky thus forming an astronomical calendar: groups of stars forming an archer, a fish or a crab. This is done simply by applying a talent that is natural to humans: finding similarities between new experiences and what is already familiar to us.

Research on the nature of metaphors and their role in discourse and thinking –and, especially, on their role in creative thinking– has been conducted from the fields of linguistics and psychology. In 1983 Gentner proposed a model to explain analogous thinking: *the structure mapping* theory. According to Gentner, metaphors involve mapping knowledge from a source domain that is known, to a target domain, that is unknown and that individuals strive to explain through the former, shaping a new system of relationships between both source and target in which elements are combined. This combination may contain tiers of complexity: from relatively simple objects or relationships to complex structures as in the case of 'mega-metaphors'. In Niels Bohr's well-known metaphor using the solar system to represent the atom, this Nobel laureate is stating that people can visualise the structure of a hydrogen atom –on a quantum scale– as the structure of a planetary system in which the centre, i.e. the Sun, corresponds to the nucleus of the atom, and is surrounded by planets, represented by electrons spinning around the nucleus.

Lakoff, from a linguistic stance, dismissed the traditional view on poetic metaphor, sustaining that metaphors are not composed merely of words, and that the generalizations governing poetic expressions do not reside in language but, rather, in thought. The conceptual system proposed by Lakoff and Johnson in 1980 introduced the concepts of 'target-domain' and 'source-domain'. The principal function of metaphor is to facilitate understanding of an abstract or unstructured domain by means of another that is familiar or well structured. In referring to the metaphor 'love as a journey', I am using a set of ontological correspondences characteristic of mapping. Again according to Lakoff (1993, p. 207), mapping to define the metaphor 'love-as-a-journey' includes:

The lovers correspond to travellers
The love relationship correspond to the vehicle
The lovers' common goals correspond to their common destination on the journey
Difficulties in the relationship correspond to impediments to travel.

This example fits very well with Lakoff's definition of metaphor as 'cross-domain mapping'.

Differences Between Metaphor and Analogy

Generally speaking, in the literature it is difficult to make a distinction between metaphor and analogy, and these are frequently equated. Thus, for instance, Johnson-Laird saw analogy as a resource that allows explaining a problematic domain of knowledge

(target), through a familiar domain of knowledge (source). The correlation between this definition and those given for metaphor by Lakoff and Gentner is undeniable.

In cognitive terms, both effectively involve the same mental process: a cognitive process to explain the unknown using what is known. An Aristotelian influence is present in this distinction. Aristotle found that analogy is a type of metaphor requiring greater complexity: whereas a metaphor establishes a relationship between two terms (A is B), an analogy involves four terms (A is to B as C is to D). Handbooks in cognitive psychology refer to analogous reasoning, in line with the Aristotelian tradition, and it is considered as a tool for solving problems; wherever individuals seek to understand new situations by establishing a parallel with prior situations we are using analogous reasoning. And when speaking of ill-defined problems, addressed by creative thinking, they fall back on analogous thinking in terms of analogies or metaphors as tools (though not the only ones) to deal with such problems and generate ideas that are original and useful, or in other words, creative.

Although metaphor and analogy both equally imply a mental process of structure mapping, some researchers, nevertheless, explicitly agree (see [Gentner et al., 2001](#)) that metaphors allow for broader variability. Moreover, according to the same authors, while metaphors are more specific and apply to affective-expressive purposes, analogies tend to have more explanatory and predictive uses.

This distinction brings up the classic dichotomy between artistic and scientific creativity: analogies would appear to belong to the world of science and metaphors to that of literature or the arts, in line with the distinction between the quest for truth vs. the quest for beauty.

However, [Romo \(2019a\)](#) found that this rather simplistic trend toward dichotomizing what minds produce: art and science, beauty and truth, emotion and reason, is nothing but a fallacy. Feyerabend, the anarchist philosopher of science (as he called himself) connected science and art, identifying science with myth, claiming that both are narrative forms, constructions built on facts; both interpret and aspire to encompass and explain the two.

Similarly, Lorena Preta in her book on metaphors in science discussed the arbitrary division into two epistemologies, one for knowledge on the natural world, paradigmatic and timeless, and another for gaining knowledge of the human world that is full of subjectivity, intentions and emotions. In addition, “we are increasingly aware that it is not possible to draw reliable conceptual confines between reason and emotion” ([Preta, 1993](#), p. 25).

Many artists and authors envisage their work as a path toward reality, to explain the external or internal world (for instance, surrealism would use the world of dreams as a source of inspiration) and numerous 20th century scientists have referred to the aesthetic experience present in their creative work. As Albert Einstein put it:

It has been said that I have been inspired by Mach's philosophy. It is not true: (...) I have been inspired by something different; in which I believe that the architecture of the laws of nature must have beauty and harmony. And relativity gives it.

Einstein in [Marina \(1993\)](#) p. 325.

The list is very extensive. In the case of Poincaré and Dirac in mathematics, mathematical beauty is a guarantee of truth. In the field of physics, Planck, Michelson or Feynman likewise refer to the beauty of scientific theories. Not to mention the geniuses of the first scientific revolution such as Galileo and Kepler, whose preconception of the aesthetic and the sublime permeated their interpretation of the universe. Kepler attempted to explain planetary orbits around the Sun in terms of a theory of inscribed solids, in which the five perfect geometric shapes defined by Pythagoreans and Plato would explain the movement of the known planets; but observation data obliged him to accept, albeit reluctantly, elliptic orbits. Galileo opposed this vehemently and adhered to the explanation involving circular orbits, simply for aesthetic reasons: it was not possible for celestial bodies' movements to follow such an imperfect figure as an ellipse, which is nothing other than a deformed circle ([Image 1](#)).

At this moment in history, when the disaggregation and compartmentalization of scientific knowledge that peaked at the beginning of the last century has now declined; now that schools are calling for the integration of subject knowledge in order to instil creativity in children; and we are reclaiming the model represented by Leonardo da Vinci, the Renaissance polymath, the dichotomy mentioned above: beauty vs. truth; art vs. science, now seems artificial.

[Root-Bernstein \(1999; p. 368\)](#) spoke of

... reconciling poetry with physics, art with chemistry, music with biology, dance with sociology and any other possible combinations of aesthetic knowledge and analytical knowledge, thus helping people to feel what they wish to learn and to know what they wish to feel.

In this context, the attribution of metaphor to art and analogy to science seems increasingly contrived. Let us explore below which types of metaphor to examine, and their role in creative production.

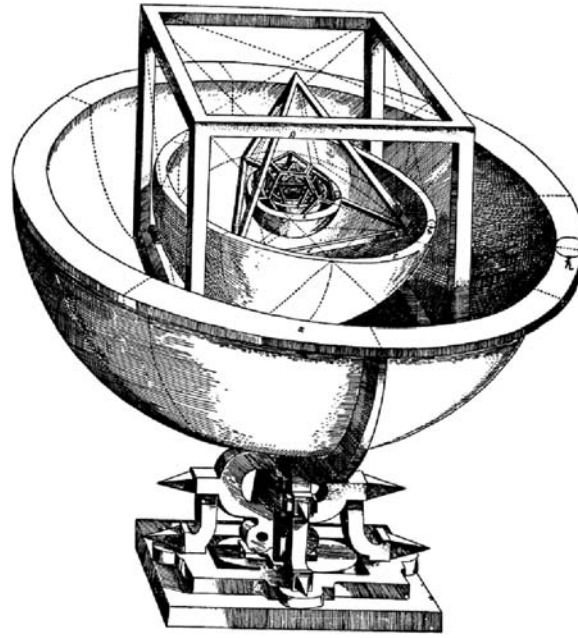


Image 1 Kepler's platonic solids model of the solar system.

Types of Metaphor

The first classification is the result of a very clear criterion: the distinction between 'metaphors new and conventional', as stated by Lakoff. The most commonly used metaphors are conventional, part of our community's linguistic repertoire, and have become automatic in our everyday use of language. Conceptual metaphors fall into this category. In the metaphor 'love is a journey', Gibbs (2011) offered several possibilities in which English speakers refer to their love relations: we're headed in opposite directions, our relationship is at a crossroads or our marriage was on the rocks. The mental effort required to use these metaphors is limited to the task of recovering from semantic memory, and does not involve the creative task of establishing from scratch a correspondence or mapping between systems of relationships for the two domains in hand.

The same is true in science when metaphors are used in discourse. For instance, when speaking of stem cells, genetic code or black holes; or in psychology, when Freudian terminology is used such as cathexis, latent content of dreams; or with terms coined by William James such as stream of thought; or behavior as motivated by the Lucifer effect or the Pygmalion effect.

A second classification criterion is related to extension. The differentiation between 'micro-metaphors and mega-metaphors', in a classification proposed by Werth (1994) to distinguish localized metaphors used at given points in the discourse to refer to specific content, known as micro-metaphors. Among those mentioned in the previous paragraph, the following are considered to be micro-metaphors: cathexis, latent content, Lucifer effect and Pygmalion effect. Mega-metaphors work on a deeper level, affording greater coherence and depth of meaning to the overall discourse. The theories of selfish genes, black holes or William James' stream of thought clearly belong to this category. In cognitive psychology, the computer metaphor became popular in the 1960s. Though not attributed to any individual author, its transcendence influenced the consolidation of the cognitive revolution and was instrumental in handling the new information processing issues to be addressed under this discipline as opposed to those dealt with for 40 years according to the behaviourist paradigm. The computer-metaphor, just as the selfish gene or the genetic code, are explanatory models that serve as a guideline to establishing the premise for a new theory and a source of recommendations for extending its applicability. Some authors, as pointed out by Ortony (1993) in his book *Metaphor and Thought*, are of the opinion that these type of metaphors would be more aptly described as analogy.

Another important classification for metaphors in the field of science has been given by Boyd (1993), who differentiated between 'pedagogical and constitutive metaphors'. The latter are similar to those described for the mega-metaphor category. The former play a role in the transmission and comprehension of scientific theories: an example is the atom as a solar system, used by Niels Bohr. Constitutive metaphors, however, play an essential role in formulating scientific theories or constructs (the selfish gene, the genetic code or black holes) since without them, according to Boyd, theory is incomprehensible.

In the psychology of science, Darwin's famous image of a 'branching tree of nature' has always been present as a broad metaphor. This image was used at critical moments in the development of his theory, always to express his central argument relating to an organic whole made up of the aggregate of a set of essential parts, whose importance became patent as it was the only illustration in Darwin's *On the Origin of Species*. Gruber described this analogy as a 'image of wide scope', defining it as a pattern that encompasses a wide range of perceptions, actions and ideas and that may be inclusive of further analogies. For Gruber, these are essential components of any theory. In this sense, they relate to Boyd's notion of constitutive metaphor (See Evolving Systems Approach).

Darwin's work, furthermore, is full of other simpler and well-known metaphors, such as war, struggle and selection, that can be compared to Boyd's pedagogical metaphors, and also to the micro-metaphors in the classification by Werth.

William James also used metaphors freely, with a clear descriptive purpose regarding his functionalist conception of the mind: continuity, change, selection, unity and relationships among the elements of thought. According to Osowski (1989), stream of thought also fulfils this 'image of wide scope' role, including others such as chain, train, path, channel, line, etc. and reflects his vision of experiencing the phenomenon of thinking with complex flow as its essential feature (See Flow).

Sigmund Freud, too, borrowed metaphors from the realm of physics to represent the balance of energy and tensions among the three instances of psychic life: the unconscious, preconscious and conscious in his first topic, or id, ego and super-ego in the second topic. In this construct, the hydraulic model afforded him considerable heuristic value and also constitutes a metaphor in the long-range category as seen in the view taken by Gruber and colleagues. Through conducting case studies, these authors showed how metaphors in creative work are never isolated, but operate as articulated groups, sometimes embedded in others with a broader outreach. Only this method makes it possible to analyse their emergence and evolution, as masterfully achieved by Gruber in his book *Darwin on Man*.

Metaphors and Creation

In formulating and solving ill-defined problems, in the search for valuable new ideas in any field, creative thinking resorts to metaphor as a useful heuristic to achieving that goal.

However, depending on the domain, the role of analogous thinking varies widely. Thus, whereas in poetry it is, without discussion, the result of a process: the product itself; in music, other literary forms, fine arts or advertising it may or may not be the product, but will appear systematically throughout the process. This is also true in science, although, strictly speaking, certain forms of scientific discovery, especially serendipities where the role of chance is determinant and metaphor occurs seldom.

By way of an example in poetry, here are verses from *Romance de la Luna, Luna* by the Spanish poet Federico García Lorca, a tale of how the Moon led the child away from the forge, stealing him from the Gypsies. Each stanza holds fine metaphors playing with the white moonbeams as an implicit source domain:

La luna vino a la fragua / The moon came to the forge
con su polisión de nardos / in her creamy-white robe
El niño la mira mira / the child stares, stares
El niño la está mirando / at the moon the child stares

En el aire conmovido / In the unsettled air
mueve la luna sus brazos / the moon stirs her arm
sy enseña, lúbrica y pura, / to show, voluptuous and pure
sus senos de duro estaño. / her breasts of hard tin

Huye luna, luna, luna. / Away, moon, moon
Si vinieran los gitanos, / should the Gypsies come now
harían con tu corazón / they would have your heart
collares y anillos blancos. / to forge white necklaces and rings

A second example is the case of Charles Nicolle who, through auspicious insight recognised the agent that halted the spread of typhus at the general hospital in Tunis. As he told the story, the barrier was the door to the hospital. Automatically, the problem was formulated and ready to be resolved: if within the hospital the disease was not transmitted, but outside it was, then there was something that patients carried with them but did not cross the hospital threshold: louse! This was the mechanism for the spread of endemic typhus, present outside but not inside the hospital. All he had to do was to prove his hypothesis experimentally.

And, thirdly, an examples of serendipitous discoveries free from metaphor is the discovery of penicillin, the planet Neptune, conditioned reflexes and gravitational waves. Nevertheless, despite the absence of metaphor, the discovery cannot be attributed to chance because, as noted by Pasteur, chance favours the prepared mind. In some cases, these are findings that pave the way for the development of complex theories: antibiotics, or the learning theory. In others, they are the necessary consequence of forecasts consistent with a previously developed complex theory. The planet Neptune confirmed an earlier discovery of greater import, namely universal gravitation: if the orbit of the planet Uranus was altered at a point on its path it was because there must be another planet exerting gravitational pull. Gravitational waves have been discovered, also by chance, 100 years after Einstein predicted their existence in his General Theory of Relativity. Speaking of Einstein, it is appropriate to recall here his words in a letter to the mathematician Hadamard, in which he was able to discern, thanks to his introspection, the psychological nature of the mental process in hand: analogous thinking.

Words or language do not seem to play any role in my mechanism of thought. The physical entities which seem to serve as elements in thought are certain signs and images, that are more or less clear, which can be "voluntarily" reproduced and combined [...] This combinatory play seems to be the essential feature in productive thought.

Einstein in Ghiselin (1952), p. 43.

In actively searching for strategies to formulate and solve problems, analogy can provide a rich source of ideas and scientists use it regularly (See analogies). Recourse to metaphor by creators in any sphere is systematic and constant, in one form or another: either as result (this includes not only instances such as the *Romance de la Luna*, *Luna*, but also the complex scientific theories mentioned above). These theories cannot be grasped other than through a defining constitutive metaphor or as instrument, in approaching the formulation and resolution of the problem or as a mechanism for intelligibility, as seen in the classification proposed by Boyd.

The age of logical positivism, in which science is viewed as a literal characterisation of reality expressed through scientific language, is over. In this context, as advised by Ortony, a constructivist approach should be adopted since knowledge of reality is a construct that reaches beyond the information received. The major role of metaphors as a means for gaining knowledge, as discussed here, owes much to the Kantian epistemological position: people construe the world within the restrictions of knowledge and language.

Theoretical proposals for explaining the process stemming from the realm of Psychology of Creativity are closely related to Einstein's words, reproduced above.

Mednick (1976), in his paper *The Associative Basis of the Creative Process* defined his thesis on association in creative thinking:

The forming associative elements into new combinations which either meet specific requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution.

S. Mednick in A. Rothemberg and C. Hausman (1976) p. 228.

It is strongly based on the introspective references of Poincaré who spoke, as did Einstein, of his creative experience in mathematics as a mental combinatory play of mutually distant concepts (See Remote Associates).

Another great architect of combinatory theory in psychology was Arthur Koestler who in his book *The Act of Creation* offered his concept of 'bissociation'. Bissociation is the act of thinking, of connecting independent mutually remote matrixes, of successfully transcending the framework of reference for a given conceptual system and connecting it with a different reference framework. This provides many instances of the use of analogy in science. An interesting precedent, evidently, to the notion of metaphor held by the authors mentioned here though with a rather phenomenological focus and constant recourse to mysterious processes of the unconscious.

In ordinary thinking, according to Koestler, we act within frameworks of reference following logical discourse criteria guided by normally conscious processes. In creative thinking, by contrast, flexible thought processes allow exploration to follow subconscious routes that lead to bissociation in an act of rebellion against the order and discipline of conventional thinking.

Albert Rothemberg coined another neologism to refer to the same thing: Janusian thinking, in allusion to the Roman God Janus, represented with a two-faced head. Creation, too, has two faces, as it implies the ability to simultaneously consider two or more opposed ideas or images during the mental process in which they will be modified, transformed and used for artistic, scientific or other purposes.

The cognitive style known as 'overinclusion' put forward by Hans Eysenck likewise contributes to the thesis of combinatory play, and is characterized by broad associative gradients and extreme generalization of stimuli. The frontiers of meaning for each concept are poorly defined, and, according to Eysenck, this style is common to creativity and psychosis alike, although in creative thinking, as opposed to schizophrenic thinking, a critical assessment is made of the outcome of superinclusive thinking, selecting only the most fruitful associations.

In the systematic and current version of the combinatory approach, an author who made valuable contributions to the discipline of Psychology of Creativity is Robert Sternberg. According to his concept of 'semantic feature spaces' the goodness of metaphors depends on maximising the distance between the two domains involved. A good metaphor uses regions in two remote conceptual spaces. This concept of goodness or 'aesthetic pleasingness' is in contrast with the notion of 'comprehensibility' that requires minimising the distance between the two domains.

Admittedly, it is difficult conducting empirical research regarding how metaphor works in the creative process. Although some studies have been conducted, as in the case of Dumbor with biologists in a laboratory, most research has been qualitative in nature and based on case studies, as in the case mentioned above of the research team led by Gruber.

A final important topic related to the psychological nature of metaphors used in creativity is the relationship between artificial intelligence and creativity. The issue to address is: can computers make metaphors, and if so, what kind of metaphors?

It is clear that this is not simply a cut-and-paste process. Ideas merge giving rise to a new reality. It is possible to create artificial intelligence programs capable of combining concepts. With this type of software, mermaids could be achieved by combining, through algorithms, fish and women, but as noted by Margaret Boden no one would hear their song; only mermaids created by poets sing.

There must be some exclusively human trait in what writers do when creating poems that computers —capable of winning at chess against an expert player, painting pictures that have been exhibited in art galleries or writing more or less bland narrative— cannot replicate in an indisputably creative manner. Perhaps life experience, emotions or human relationships are the source on which the powerful creative heuristic, analogous thinking, thrives.

However, science is much closer to understanding in computational terms and, perhaps, to reproducing, the workings of analogous thinking, as Margaret Boden anticipated 27 years ago in his book *The Creative Mind*. This has come about with the connectionist models capable of replicating more accurately the workings of the human brain. Parallel distributed processing software produces a form of visual representation on a system-wide activity pattern, in which connections are weighted according to their likelihood. This means that, when two units are active simultaneously, they will adjust their connection weights to raise the likelihood of becoming simultaneously active in the future, too. Moreover, these programs that are more “analogous” to the human mind still do not function according to explicit rules specifying which contents should necessarily become connected.

The advances made in artificial creativity cannot be denied. In 2017 Elgammal et al. presented the *Creative Adversarial Network* for generating art. This system generates art by viewing art (accessing 80,000 works) and learning different styles. The program is equipped with a generator able to create novel works with stylistic ambiguity whose artistic value lies in their arousal potential that deviates from learned styles. This arousal is conceived by the authors as a form of artificial motivation.

However, AI has not yet acquired the capacity to produce any work that can be described as ‘eminent’ or ‘big creativity’ or, in the words of Boden, to conduct transformational creative activities. This capacity is hindered by the lack of an algorithm capable of breaking previously established algorithms. This is one of the reasons why AI products are unable to reach big creativity levels: the software programs are constrained by their operating algorithms. Human beings, by contrast, are endowed with such set-breaking capacities, the ability to exit conceptual spaces and create other new ones according to previously unknown rules, and can break paradigms to build new ones.

On the Utility of Metaphor

The opening of this chapter gives a clue to understand the greatest value that metaphor holds for human beings: it is a way to approach and learn about the world, to expand knowledge by explaining the unknown in terms of the known.

Rumelhart (1993) stressed the importance of metaphor as an essential ingredient in language acquisition, already present in early stages of development and a natural linguistic phenomenon. By applying familiar words to new objects or situations, infants extend their knowledge sometimes with conventional metaphors and sometimes creating new ones that adults will correct to a greater or lesser extent. But since in creativity productive and critical thinking go together, at a later stage in this evolution, when children are between the ages of 6–8 and 10–12 years, they learn school and out-of-school rules. Children develop critical and evaluation skills, and the quest for realism negatively affects their earlier capacity for metaphor. Gardner calls this period the ‘literal stage’ in which children gain with the incorporation of rules and normative knowledge while at the same time suffering a loss in their metaphorical thinking and tolerance of fantasy.

Across the various domains of creative output the role of metaphor varies. Thus, throughout the arts in general, metaphor contributes to the capacity to convey emotion and aesthetic sensations that the works of great painters, musicians and, in particular, gifted poets awaken in us.

Scientists themselves perceive aesthetic sensations that are perceived too by scholars immersed in studying the complex theories presented through the use of constitutive metaphors. In science, however, perhaps the greatest utility of metaphors falls to those Boyd described as pedagogical, i.e. metaphors that convey and render comprehensible complex knowledge. Metaphors used by authors through the history of psychology to explain the phenomenon of creativity include the following concepts: inspiration, enthusiasm, incubation, illumination, breaking frontiers or synthesis of opposites.

In addition to conveying knowledge a further function of metaphors in science includes persuasion this function aims to convince the scientific community of its own importance. However, this entails the danger of discourse becoming hollow and unproductively rhetorical, as warned by Sokal and Bricmont in their work *Intellectual Impostures*. They accused some authors of inappropriate use, in the field of social science, of metaphors taken from natural science, presumably to achieve on the one hand a more prestigious image, and, on the other hand, to deflect attention from any potential conceptual or empirical shortcomings in their discourse.

To follow on with this argument, there is the further noxious effect of some metaphors in the history of science. The animist view of nature upheld for centuries, a legacy of atavistic anthropomorphic explanations of natural phenomena occurring in myths, held back scientific advancement. For instance, the belief in the ‘horror vacui’ of nature competed for a time with Torricelli’s theory of atmospheric pressure to explain the effects of suction pumps to obtain water from a well.

In a more pragmatic sense, where metaphors are found to register the greatest economic value is in advertising, design and innovation within organizations. TV during prime viewing time bombards the viewer (to use a military metaphor) with advertisements that attempt persuasion by deploying metaphors, more or less aptly chosen, in their spots (See advertising).

Moreover, the production techniques for creative ideas applied in these fields are based on metaphors, their production and their evaluation and selection. The *Synectics* technique devised by William Gordon considered converting the strange into familiar and the familiar into strange as a strategy, and the procedure consists in mass producing metaphors in any of four types: personal, direct, symbolic and fantastic. *Synectics* provokes new approaches: to see familiar things as strange, so that previously concealed

dimensions are perceived or to see new things as familiar and to explain them through known principles and relations. All this leads to producing novel ideas that are useful in dealing with ill-defined problems in the mentioned fields.

It is not so easy, however, to find the right metaphor in any field. As mentioned earlier, cut-and-paste will not work. Not everyone, after the literalism stage, recovers their free and productive childhood thinking that allowed them to find relationships among things. Sometimes, this capability simply fades and becomes atrophied over time. Some people are simply unable to see familiar shapes in the clouds and, from here to the poems of Garcia Lorca, there is a wide gap to fill. There is a bidirectional relation between creativity and analogous thinking, which is why this mental function should not be overlooked in education.

Fairweather and Cramond (2010) emphasized an interdisciplinary approach and teaching for transfer, promoting the use of analogies; i.e. space exploration with the discovery of the New World. Using pedagogical analogies facilitates the learning of new things and new concepts.

Creativity in education can be both a tool and as a target: teaching methods based on a creative model and aiming toward educating more creative individuals; and in this aim, training in analogous thinking should be a priority in schools and at university (See Creativity in the Classroom).

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Millennials

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Introduction

An indisputable fact about the digital era is that progressive technology advancements serve as a catalyst for many changes and are thereby changing every aspect of our lives. Technology requires employees to work longer and faster and to be constantly connected; as such, technology can be regarded as invading the personal lives of employees. Moreover, in today's increasingly dynamic work environment, employees often face complex and non-routine challenges; therefore, they are expected to be more creative (i.e. to generate novel and useful ideas).

However, technology has not only impacted the nature of work; it has also shaped the development of a new generation of millennials, also known as "Generation Me," "digital natives" and "Generation Y." As the fastest-growing segment of the workforce, expected to comprise 35% of the workforce by 2020, millennials seem to be invading workplaces. Through their exposure to digital technologies, millennials, relative to people from previous generations, have developed higher expectations about their work, especially about its meaning and purpose. Further, they are seeking out organizations that reflect their personal values and capitalize on their strengths, enabling them to use their talents and creativity to do what they do best, providing them with possibilities to learn and develop and, most of all, providing them with jobs that match their personal lives.

The popular press widely assumes that millennials are not loyal to their organizations and have no problems switching employers if their needs and expectations are not met. Millennials are not willing to adapt their lives to their work but, instead, prefer to adjust their work to square with their life expectations. Studies also suggest that millennials' values and preferences differ from those of workers from previous generations and that these value differences may decrease the effectiveness of current efforts to amplify employee creativity. Millennials are thus forcing companies to adapt and remove long-established traditional workplace structures and policies to engage, manage and retain millennial workers and to exploit their creative potential.

Despite the fact that millennials are one of the greatest assets of future organizations, the organizational literature is relatively silent about how millennials' prevailing characteristics will influence their creativity at work. Therefore, the aim of this chapter is to deepen our understanding of how work environments can be redesigned to better suit millennials' needs, thereby boosting their creativity. Specifically, we explore how work environments might be redesigned to take advantage of millennials' talents to provide meaningful work, enable them to experience the required work-life balance, and thereby increase their creativity.

Millennials' Invasion of Workplaces

The general impression is that millennials' salient characteristics, values and work expectations represent a radical change; this begs the question of whether current workplaces whether current workplaces and systems are equipped to accommodate the needs and expectations of this digital generation of workers. According to [Hershat and Epstein \(2010\)](#), it is crucial to strike the right balance between expecting millennials to adapt to current organizations and adapting organizations to better suit them. Thus, scholars and practitioners must overcome the challenge of rethinking and redesigning work to align it to the needs of incoming digital-generation workers. In what follows, we describe millennials' characteristics and work expectations, which set this generation apart from previous generations. Based on these distinct characteristics and work expectations, we present a (millennial) expectations-based revision of the job characteristic model (i.e., the "it's all about me" model) that promotes creativity and other organizationally relevant outcomes (see [Fig. 1](#)).

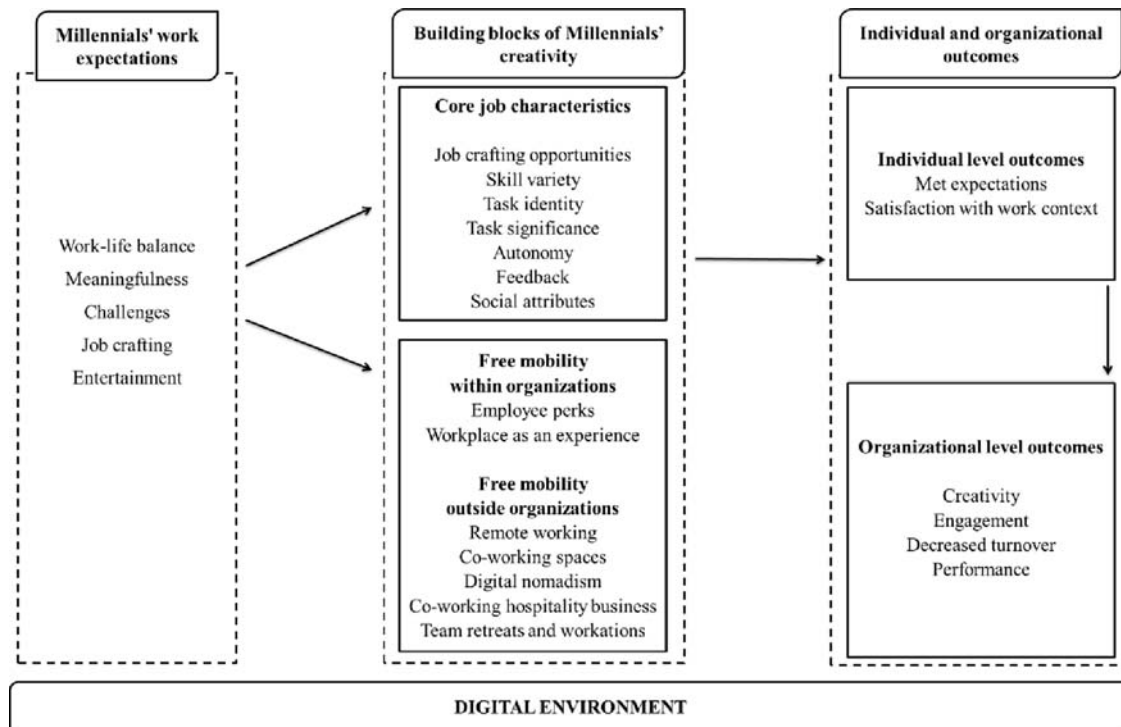


Figure 1 "It's all about me" model.

Millennials' Characteristics and Work Expectations

Millennials, those born between the early 1980s and the late 1990s, grew up in a fast-paced, technology-dominated society and are thereby more technology-savvy than members of previous generations. These incoming employee cohorts are more digitally adept and attuned than previous cohorts (e.g., baby boomers, Generation X). Digital technologies—computer hardware, software, smartphones, the Internet and networks—are an integral aspect of their everyday lives. Therefore, they are fluent in the digital language and completely immersed in technology. According to the World Economic Forum, on average, Millennials spend more than 7 h a day online. They have natural ability that they have honed into formidable skills in the use of new technologies. Moreover, millennials' thinking and information processing is fundamentally different from that of previous generations.

Millennials are stereotypically characterized as individualistic, self-centered, optimistic, entitled and disloyal. They are considered to have higher levels of self-esteem than members of previous generations, along with an external locus of control, and they are extraordinarily confident in their abilities. Although empirical research confirms that they are extrinsically motivated, intrinsic values, such as learning and development, have also been identified among millennials' top work values. Millennials have been raised in environments that are rich with feedback, individual attention, praise and guidance (Hershatter and Epstein, 2010); therefore, they expect such treatment in the work environment.

In addition, even in the context of work, they are focused on their individual development; millennials seek career advancement, looking to embrace a challenge and thereby develop new skills. That said, they are described as an intelligent, informed, open-minded and responsible generation that enhances organizational speed and efficiency. However, they are also perceived as demanding employees, who often express their opinions: they have a low tolerance for boredom; they thrive on new challenges; and they value respect, recognition, involvement, fairness and supportive management. For millennials, work is "no longer a place you go, but a thing you do" (Thompson and Gregory, 2012, p. 242); therefore, they insist on freedom of choice, preferring to work when, where and on what they choose. Therefore, millennials will more likely take the initiative to craft their work to reflect their values, needs and passions. Thus, they are aligning their working environments with their work expectations (e.g., establishing a good work-life balance, being involved in challenging, meaningful work and having fun at work).

Building Blocks of Millennials' Creativity

Millennials are considered to be creative; however, they must be engaged in meaningful work that allows them to use their creativity and passion to create value (Espinoza and Ukleja, 2016). Research has demonstrated that good work-life balance, meaningful work, challenging work, job crafting opportunities and entertainment can contribute to millennials' loyalty, retention and creativity, prompting them to bring waves of talent and technical expertise to their work in ways that benefit their organizations. To capitalize on millennials' creative talents, organizations should create work environments that facilitate the personalized motivation required

by millennials and thereby maximize their potential. [Deloitte's survey \(2017\)](#) showed that millennials strive for connections between past and future workplace settings, combining freelance flexibility and full-time stability. We therefore argue that to enhance millennials' creativity, work should be aligned with millennials' expectations. In what follows, we present the future job characteristics that will facilitate such an alignment. Specifically, we first describe the core job characteristics and then introduce free mobility (i.e., the opportunity to move freely and easily) as an important job element that enables millennials to satisfy their need for free stability (i.e., freedom and stability), thereby boosting their creativity.

Core Job Characteristics

Millennials strive for work they perceive as meaningful, indicating that they expect to choose their work and set the terms under which they will engage in their work. Work environments should therefore provide opportunities for millennials to craft their jobs and to change their work to align it with their preferences, motives, skills and abilities. According to [Berg et al. \(2010\)](#), individuals craft their jobs to create opportunities to work on enjoyable and meaningful tasks by: (a) devoting more attention, time, and energy to such tasks; (b) taking on additional tasks that provide enjoyable and meaningful experiences; and (c) reframing the social purpose of individuals' work to align with individuals' purpose-driven experiences. As millennials expect flexible working arrangements that will allow them to take a work deferral to explore their passions, we argue that job crafting opportunities must become one of the core future job characteristics that can be understood to increase millennials' creativity.

Further, job characteristics significantly contribute to the extent to which employees invest more of their time, effort and skills into their work. [Oldham and Hackman \(2010\)](#) argue that significant motivational factors that promote desired psychological states (i.e., experienced meaningfulness of work, responsibility for work outcomes and knowledge of results) include the following job characteristics: greater skill variety, or "the degree to which the job requires a variety of different activities in carrying out the work, involving the use of a number of different skills and talents of the person" (p. 464); task identity, or "the degree to which the job requires doing a whole and identifiable piece of work from beginning to end" (p. 464); task significance, or "the degree to which the job has a substantial impact on the lives of other people, whether those people are in the immediate organizations or the world at large" (p. 464); autonomy, or "the degree to which the job provides substantial freedom, independence, and discretion to the individual in scheduling the work and in determining the procedures to be used in carrying it out" (p. 464); and job-based feedback, or "the degree to which carrying out the work activities required by the job provides the individual with direct and clear information about the effectiveness of his or her performance" (p. 464). We argue that, for organizations to capitalize on millennials' creative talents and potential benefits, core job characteristics should be aligned with their work expectations. Namely, millennials will bring all their skills, traits and knowledge to the workplace; however, they seek the best return for their input of time and energy, and they require job autonomy, freedom, flexibility and meaningful and challenging work ([Aruna and Anitha, 2015](#)). As Millennials value personal development, they must have the opportunity to engage in a number of activities that will allow them to use a broad range of their skills and talents (i.e., have the opportunity to use different skills on a variety of tasks), including problem-solving, team collaboration and technical skills. They also seek out creative challenges; therefore, organizations should continue giving them challenging tasks to prevent boredom. Once millennials master their jobs, they have no problem finding another challenge by switching their jobs ([Lyons et al., 2015](#)). However, it is important to note that millennials also have a strong preference for clear guidelines, structure and systems that support their needs. Although they confidently complete their work from start to finish, along this path, they expect detailed instructions on how to complete their tasks. Thus, we argue that when their core job expectations and needs are met, Millennials are willing to accept some potential constraints of the workplace and are able to find ways how to work with and within them.

Free Mobility Within and Outside Organizations

Digitalization has enabled employees to work at times and places that are convenient to them and facilitate their work-life balance expectations. Gallup's recent 2017 survey on the State of the American Workplace, using data collected from more than 195,600 U.S. employees, confirmed that respondents (especially millennials) are focused on their lives, not only on their jobs. One important consideration among highly talented employees, when negotiating for jobs, is remote working and flexible vacation policies; in millennials' eyes, this enables work-life balance and travel while they hold a full-time role at work. Remote working provides a release from the restrictions of office based hours ([Grant et al., 2013](#)), which has a positive impact on Millennials' perception of work-life balance. However, it is also important to note that remote technology also provides ease of access to work and organizations now often expect employees to keep in touch with work both inside and outside of work time ([Grant et al., 2013](#)). Scholars also argue that technology-driven changes have blurred the boundaries between work and non-work life domains and created a need to renegotiate the relationship between employees and organizations.

Organizations thus face the challenge of how to restructure organizational work to make it suitable for millennials' work preferences and needs and re-establish the relationships between employees and organizations in the digital era. We argue that organizations should provide free mobility opportunities (i.e., opportunities to freely move within and outside organizations) and thereby provide millennials the flexibility required to obtain personal and professional satisfaction. Given that millennials expect a workplace with no boundaries and a fun atmosphere that allows them to be entertained at work, we argue that their work expectations enhance the development of free mobility within organizations. For example, to enhance millennials' creative talent, Silicon Valley tech companies, in addition to monetary awards, provide various perks, such as gyms, swimming pools, different indoor and outdoor courts, video games, places to sleep or rest, free meals and free (or subsidized) services, such as dry cleaning, massages,

health and dental, haircuts, the option to bring their pets to the office, etc. Thus, they attract and retain the best millennials. For example, the pioneer in the field, Google, offers quite a lot of free mobility within the company, enabling employees to move to new teams, projects and departments and spend some time working on individual projects, outside of their day-to-day tasks, that interest them (Hartmans, 2017).

Moreover, for millennials, the work environment is a place to learn, collaborate and socialize; they therefore want to work in a comfortable and socially enhancing environment (Aruna and Anitha, 2015). Organizations are thus restructuring their work environments to make them more suitable for the millennials generation. For example, Airbnb employs a global head of employee experience and goes beyond creating experiences central to the “place of work” (such as access to gym facilities, free massages and gourmet food), making the workplace an experience where “all the elements of work—the physical, the emotional, the intellectual, the virtual, and the aspirational—are carefully orchestrated to inspire employees” (Meister, 2015). Airbnb offices are designed on the basis of employee input in how they want to work, which even extends to allowing employees to design some of the meeting rooms on their own. The spaces are meant to be welcoming so employees feel like they are at home, and meeting rooms are inspired by travel (designed as replicas of the places they offer on the platform), crafting an environment where they can belong anywhere. Companies are also introducing new ways of working, like no-meeting days (e.g., no-meeting Wednesday), devoting one day of the week to core activities and providing time for thoughtfulness and productivity without the interruptions of time-consuming activities.

We further argue that, for millennials, the aforementioned practices are not enough. This is to say that millennials also strive for freedom, mobility, flexibility and autonomy outside organizations. Consequently, based on the expectations of millennials, we are witnessing the rise of several different innovative work design practices, which enable greater work-life balance, satisfaction and personal growth, while strengthening inter-organizational connections, engagement and trust. By giving millennials the option to work remotely, organizations increase employees’ well-being, including their work-life balance, and lower stress levels, while reducing costs and enhancing creativity and productivity. Therefore, increasingly more multinationals (e.g., Apple, Disney, American Express, Xerox, Intuit, etc.) are providing a chance for remote working, following the motto, “If you want people to do great work, let them. And stop caring about where they do it.” (Outsite, 2017). Millennials expect to have the freedom to work when and where they choose; however, at the same time, they also require stability, clear structure and guidance. Thus, co-working spaces may also be appealing to millennials. Co-working places are built around the idea of community-building and sustainability, and address the needs of independent professionals with different knowledge backgrounds (and work-life characteristics of freedom and independence) to overcome the feelings of isolation and loneliness when working from home. The purpose of these places is to create a community, composed of likeminded value-oriented (rather than competition-oriented) intellectual workers in the knowledge economy, and give the members of that community the opportunity to network and connect with a greater intent of developing potential business ideas. There is a high degree of trust among community members, as co-working spaces may be seen as microclusters of individuals, where those individuals (and, similarly, organizations within industrial clusters) can pool their knowledge and create network relationships to co-create and collaborate on various activities and projects. Co-working places thus address millennials’ needs, by employing nomad working practices, with an aim to combine work and leisure within the new era of reputation-based social capital.

Further, some argue that rapidly changing technology enabled instant communication and has, consequently, produced digital nomadism, which is characterized by work mobility and/or leisure and a tendency to change. Specifically, the new digital era employee’s wish for autonomy, independence, work-life flexibility and the pursuit of a meaningful career, while traveling and exploring the world, are a driving force for millennials. On the other hand, this kind of work also enables economic stability, as it can reduce costs of living by allowing employees to stay in cheaper countries around the world. By establishing autonomy, flexibility and excitement outside of work, digital nomads have cracked the code on maintaining work-life balance. Digital nomads are a new generation of employees, who combine travel with the ability to work anywhere, anytime, and may indicate the development of future ways of working. As digital nomadism facilitates enjoyment, allows individuals to take advantage of their knowledge and skills and enables a good work-life balance, it is very attractive to millennials. Digital nomadism may also be perceived as a creative break, where individuals have time to discover more work-life balance. Digital nomadism is also interesting for millennials who have settled for the option to work from anywhere, and freelancers involved in high-tech activities such as coding.

Some millennials seek, from time to time, to escape their daily corporate routine, but don’t feel comfortable with the nomad lifestyle. Thus, the concepts of remote work and co-working developed even further, to encompass co-working hospitality businesses that enable interaction and creation of a community of like-minded professionals, who play as hard as they work, while enjoying great work-life balance. Outsite is an emerging co-living, co-working community that has, to date, established its hospitality businesses in more than 12 locations around the world. The idea of Outsite is to create a work-away-from-home destination, where people can get work done and have fun in inspiring locations around the world. Outsite’s founder described the company as a “hub of entrepreneurial activity and the launching off place for new ideas from leaders looking for inspiration in a place where they can work and escape into nature ... I came up with the idea of combining all the elements that facilitate work-life balance into a co-working hospitality business intended to establish a community of like-minded professionals who play as hard as they work, guests who are as passionate about the concept as we are” (Guisset, 2015). Studies suggest that millennials prefer work that provides more vacation time. Thus, the opportunities co-working hospitality businesses provide may enable them to take some kind of (daily, weekly, monthly) personal retreat and to take off from standard work, thereby achieving a good work-life balance.

Outsite houses also host company retreats, where employees of one company live and work together for a couple of days to boost their creativity and strengthen their relationships. These houses may be defined as places where professional adults can live while on business or personal travel and meet like-minded people (traveling as students would, living in hostels and meeting like-minded backpackers). Outsite has, so far, attracted several types of remote workers, including designers, developers, entrepreneurs, artists and academics from renowned companies, such as LinkedIn, Google, Facebook, Zynga and more. Team retreats and “workations” are designed to promote interaction among employees and the building of strong relationships. As noted above, Millennials perceive work environments as opportunities to meet new friends and build strong relationships; thus, they appreciate such initiatives. Further, team retreats help companies strengthen their cultures and allow employees to connect in more meaningful and powerful ways, returning to normal work more relaxed and excited. These retreats are most effective when joined with other possibilities of new ways of work, such as remote work or “workation” opportunities, where employees have the freedom to choose where and when they work, offering them the option of being on vacations while working.

Individual and Organizational Outcomes

The job characteristics theory posits that the following three psychological states, which employees experience, generate desirable organizational outcomes: employees must perceive their work as worthwhile, valuable, or important (i.e., experience the work as meaningful); they must feel personally accountable for their results (i.e., experience personal responsibility for work outcomes); and they must know and understand (i.e., knowledge of the results) how effectively they are performing their jobs (Kulik et al., 1987). These psychological states are highly relevant for millennials, as they want to engage in meaningful work, are highly confident in their ability to achieve established goals, and expect and appreciate immediate feedback. Thus, organizations are faced with the challenge of creating working environments that their employees will perceive as satisfying.

Studies have indicated that millennials are demanding; they want to choose their work tasks and the conditions under which they will engage in their work. Millennials, also known as “Generation Me,” are more self-focused, have high expectations and self-esteem, and display higher levels of narcissism. Thus, we argue that, although experiencing the abovementioned psychological states is highly relevant to millennials, millennials’ expectations–environment fit should be a central feature of future job designs. Namely, Millennials will most likely proactively redesign their jobs to experience the abovementioned psychological states. However, this generation expects supportive work environments that meet their expectations. They are willing to sacrifice their time and energy for work as long as doing so furnishes them with personal benefits (i.e., if their expectations will be met). If their expectations are unmet, millennials tend to leave the organization within 8–12 months. Thus, to embrace talented millennials and to ensure that they will benefit their organizations, organizations should pay more attention to millennials’ personal outcomes. We argue that the aforementioned building block of millennials’ creativity (i.e., free stability, consisting of core job characteristics and free mobility) increases the likelihood that millennials will be satisfied with their work contexts and have their expectations met (i.e., to achieve personal benefits).

Flexibility (in terms of flexible working hours and flexible working locations), stability and autonomy are the most important factors for millennials when they are looking for work; these factors are linked to improved personal satisfaction, which in turn leads to increased creativity, organizational performance, loyalty and employee retention (Deloitte, 2017). To promote millennials’ creative performance and higher retention rates, organizations should create work environments that provide millennials with the flexibility needed to balance their personal lives and development, leisure and community activities.

We argue that personal outcomes will increase millennials’ work engagement, defined as “the positive, fulfilling, and work-related state of mind that is characterized by vigor, dedication, and absorption” (Schaufeli et al., 2002, p. 74). Vigor refers to “high levels of energy and mental resilience while working, the willingness to invest effort in one’s work and persistent even in the face of difficulties” (Schaufeli et al., 2002, p. 74). The more personal benefits millennials receive from work, the more time, energy and effort they are willing to invest in work, thereby indicating higher levels of vigor. Further, dedication is described as having “a sense of significance, enthusiasm, inspiration, pride, and challenge” (Schaufeli et al., 2002, p. 74). By meeting millennials’ expectations, organizations will increase their dedication to work. Namely, as noted above, millennials value meaningful and challenging work. Finally, absorption is defined as a “state of being fully concentrated and deeply engrossed in one’s work, whereby time passes quickly, and one has difficulties with detaching oneself from work” (Schaufeli et al., 2002, p. 74). As long as work yields personal benefits, millennials will show high levels of absorption. This is to say that, when involved in meaningful work, millennials can prove to be hardworking and highly creative.

Further, high work engagement leads to positive outcomes, such as organizational commitment and decreased turnover. Research shows that millennials are likelier to leave their organizations if they lose a sense of absorption, enthusiasm, meaningfulness and challenge in their work. In addition, it has been noted that millennials can be retained when their expectations regarding their working conditions, how interesting their work is, work-life balance, job security and whether they receive adequate levels of information are met. Thus, we assume that the higher the personal benefits, the higher the loyalty to the organization, and thus, the lower the turnover among millennials. Finally, studies have suggested that if millennials experience high levels of responsibility, work meaningfulness and personal fulfillment at work, this leads to higher levels of organizational performance. Thus, by increasing millennials’ personal outcomes, organizations can maximize their creative performance. Taken together, as depicted in Fig. 1, we further argue that personal outcomes are positively related to organizational ones. Specifically, to retain millennials and capitalize on their intellect and talents, jobs should be designed in such a way as to meet their unique expectations.

Conclusions

In this chapter, we address the question of how to stimulate the creative behavior of millennials, who bring their unique values into the contemporary workplace. Specifically, to explain why and how organizations should adjust work environments to boost millennials' creativity and other organizationally relevant outcomes, we have developed a model that integrates and extends the literature of millennials' characteristics and work design. To capitalize on millennials' talent, organizations should create environments that will satisfy their need for both stability and freedom. We thus developed the "It's all about me" model, in which we introduce the building blocks of creativity that provide the required free stability, consisting of seven core job characteristics (i.e., skill variety, task identity, task significance, autonomy, feedback, social attributes and job crafting opportunities), and free mobility within (i.e., employee perks, the workplace as an experience) and outside of organizations (i.e., remote working, co-working spaces, digital nomadism, co-working hospitality business, team retreats and workations). We further argue that free stability facilitates personal outcomes (i.e., met expectations and satisfaction with the work context), which in turn promotes positive organizational outcomes (i.e., creativity, engagement, decreased turnover, and increased performance).

Given that digital technology will continue to grow rapidly, researchers can make a more significant practical difference by examining how existing work-related systems may be adapted to become more suitable for new, technology-savvy generations. By introducing a set of millennials' expectations that should be considered when designing their work, the "It's all about me" model takes a step toward understanding when and under which working conditions organizations can capitalize on millennials' creative talent. Specifically, digitalization has shaped millennials' work expectations, values and preferences, which have radically changed, relative to those of previous generations. Because millennials are the most educated generation ever, they have the potential to become the greatest assets to the organizations of the future. For this to happen, job structures should be designed in such a way as to enrich the lives of millennials, thereby decreasing their turnover intentions and enhancing their creativity. Along with the suggestion that future job design characteristics should be aligned with millennials' work expectations, the "It's all about me" model also highlights the interplay between the meeting of millennials' work expectations and organizational outcomes. By accounting for how personal outcomes can influence positive organizational outcomes, the "It's all about me" model reinforces the value of investigating how work environments that enable personalized motivation affect creativity, engagement, performance and decreased turnover (i.e., positive organizational outcomes).

Moreover, recent research indicated that millennials aspire to have flexible work environments (in terms of hours and location) and stable financial resources. In the past, this combination appeared impossible; however, recent organizations addressed this need by introducing several solutions offering some sort of location independence and financial stability at the same time (i.e., free stability). The most up-to-date organizations apply hybrid approaches (i.e., combining various options for flexibility, such as remote working, company retreats and workations) with a large degree of autonomy concerning where and how to work (employees' having their own working spaces, places that support interaction with coworkers and the option of working where they would like to work) (Gallup, 2017). This chapter introduces seven core job characteristics and free mobility within and outside of an organization as the building blocks of creativity. These building blocks enable almost any organization to create a work environment that promotes free stability, thereby allowing millennials to achieve the balance they need between their personal and professional lives, thereby boosting their creativity. Taken together, the "It's all about me" model suggests that, to increase positive organizational outcomes in the digital era, job design must expand beyond the organizational context and incorporate millennials' work-to-live philosophy of life.

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Mind Wandering

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Introduction

“Stream of consciousness” was first coined by William James, who is often considered the father of American psychology. He indicated four Characters of Consciousness in his thesis:

- 1) Every “state” tends to be part of a personal consciousness.
- 2) Within each personal consciousness states are always changing.
- 3) Each personal consciousness is sensibly continuous.
- 4) It is interested in some parts of its object to the exclusion of others, and welcomes or rejects—chooses from among them, in a word—all the while (James, 1892).

Thus, consciousness has two distinct characteristics—continuous and changing, meaning that our thoughts rarely stay still. Everyone has experienced these kinds of situations: When in a meeting, the TV show that we saw last night pops up in our minds; while doing exercise, we involuntarily imagine the relaxation of the weekend. This phenomenon is called “mind wandering” and refers to the attention shift away from a primary task and toward internal information unrelated to the task. This can include daydreams about fictional worlds, as well as memories and prospective thoughts (Smallwood and Schooler, 2006). Mind wandering is a kind of experience in the “stream of consciousness”; it may appear both in the middle of a goal-oriented task and in a resting state, taking over the individual’s center of consciousness and filling in one’s “stream of consciousness.”

Although it has been a few decades since mind wandering has drawn the attention of mainstream research, this notion has been found in different fields of study in recent years with increasing frequency. As a result, mind wandering is referred to in different ways, such as daydreaming, off-task thinking, task-unrelated thought, stimulus-independent thought, and spontaneous thought. Researchers have found that the frequency of mind wandering in a task is between 15% and 50%, with the least amount of mind wandering occurring during a coding task (15%), and the most occurring during a signal detection task (50%). One study using a large sample was published in *Science* in 2010 and showed that the occurrence of mind wandering in daily life is as high as 46.9%. In this study, 30% of subjects experienced mind wandering in almost all activities (Killingsworth and Gilbert, 2010).

Mind wandering is ubiquitous and it occurs in almost all forms of activity. In traditional research, mind wandering has always been considered the enemy of concentration. In some contexts, such as when driving, mind wandering can even threaten an individual’s safety. Researchers have found that one of the most common contexts for mind wandering to take place is reading, and that mind wandering can significantly impair an individual’s reading comprehension. In addition, mind wandering has often been associated with an unhappy mind, especially when individuals were ruminating on the past.

However, in recent years, a number of researchers have attempted to delve into the positive aspects of mind wandering. Mind wandering has long been associated with an individual’s goals and considered conducive to an individual’s future planning or autobiographical planning. In 2013, Smallwood and his colleagues used an inter-temporal discounting task to examine how mind wandering changes with the amount of time participants are willing to wait for an economic reward. The results indicated that mind wandering is also involved in successful management of long-term goals, and facilitating healthy decision-making (Smallwood et al., 2013).

According to recent empirical evidence, many researchers believe that mind wandering might also contribute to creative cognition. According to their theories, as the mind wanders, remote associations are brought together into consciousness and, thus, mind wandering is likely to play an important role in facilitating creative breakthroughs.

Thus mind wandering can occur at a cost in some cases, but it may also have some potential adaptive functions.

Theories of Mind Wandering

The Executive-Control Theory

In 2006, Smallwood and Schooler proposed the *Executive-Control Theory*, indicating that mind wandering consumes executive resources in the same way as current tasks. This theory was supported by empirical evidence. First, the tasks relying on controlling processes would inhibit an individual from experiencing mind wandering. Antrobus et al. (1966) discovered in a simple signal detection task that the frequency of mind wandering would decrease if the stimulus presentation rate increased. A subsequent experiment also showed that the frequency of mind wandering would decrease as the demand for a subject's working memory capability increased. Thus, it was concluded that mind wandering and tasks were competing for an individual's limited working memory resources, and that, when the resources required by tasks increased, the frequency of mind wandering would decrease. Second, researchers indicated that the longer a task was practiced, the more the frequently mind wandering would occur. A reasonable interpretation was that practicing lowered the demand for attention in skill-based activities. As the individual was getting more familiar with the task, the demand for execution of and control over the task was reduced, fewer executive resources would be allocated to the task, and the frequency of mind wandering would increase. Smallwood and Schooler proposed that mind wandering was a process of dissociation, which transferred cognitive resources from external stimuli to internal information and therefore required the executive control resources to coordinate and integrate the relevant information. However, this theory did not seem to apply to the phenomena where people with high working memory capacity experienced a relatively low frequency of mind wandering when performing tasks that had a high demand for cognition.

The Executive Failure Account

In 2010, Mcvay and Kane proposed the *Executive Failure Account*, an integration of multiple views, challenging the *Executive-Control Theory* mentioned above. They believed that mind wandering was activated automatically, but that it neither consumed executive resources nor relied on the same cognitive mechanisms as execution and control. Instead, mind wandering reflected an executive-control failure, i.e. failure to suppress the generation and maintenance of irrelevant thinking. The function of the executive system is to adjust and maintain external attention through resisting distracting stimuli from both inside and outside; if it failed, the frequency of mind wandering would rise. According to this theory, mind wandering was an epitome of failure to stay focused on task objectives. When the demands of tasks (such as the stimulus representation rate and memory load) increased, the decrease in mind wandering frequency reflected that the control and processing system was resisting interference, rather than taking up executive resources. An individual with high executive capacity is more capable of completing the tasks accurately when compared with others, so mind wandering was less frequent. Mcvay and Kane pointed out that this theory explained performance under fatigue and drunkenness. The *Executive-Control Theory* put forward that in severe fatigue and drunkenness, the executive control resources that mind wandering required were inadequate, so the frequency of an individual experiencing mind wandering should be significantly reduced. In actuality, mind wandering was extremely high, which to some extent supported the *Executive Failure Account* theory. And again, this theory did not explain why an individual with high working memory capacity faced a high frequency of mind wandering when engaged in the tasks with a low demand for cognition.

The Component Processes Account

In 2013, Smallwood proposed the "Process-Occurrence Framework," elaborating on previous theories of mind wandering from a new perspective. The "Process-Occurrence Framework" differentiated the initial reaction phase and continuation phase of mind wandering, linking the former with Executive Failure Account, and the latter with *Executive-Control Theory*. It was believed that mind wandering was caused by malfunction of the executive control system, and that its maintenance required cognitive control resources (Smallwood, 2013). Based on this framework, Smallwood and Schooler (2015) proposed the *Component Processes Account*, explaining mind wandering from three aspects. (1) The separation of cognition from external processing. This theory held that self-generated thought separated attention from extrinsic information, thereby increasing the processing of intrinsic information while reducing the processing of extrinsic inputs. (2) Task-unrelated thought arising spontaneously. Their study found that mind wandering contained episodic and effective processes. (3) Individual's regulation of the disengagement and self-generation processes. This theory showed that executive control processes and meta-cognition played important roles in the coordination of these two processes.

Deliberate/Spontaneous Mind Wandering and Creativity

In recent research, a new focus has been put on the distinction between intentional (or deliberate) mind wandering and unintentional (or spontaneous) mind wandering. Beghetto and Corazza (2019, p. 248) noted that: "The difference between these two kinds of MW stems from the mental dynamics underlying the onset of the experience of MW: whether the attentional shift (external-internal) occurs spontaneously or, somehow, under the individual's mental control. Specifically, in cases of deliberate MW, attention is intentionally shifted from the focal task to internal thoughts, whereas in case of spontaneous MW, task-unrelated thoughts capture one's attention, triggering an uncontrolled shift from the task at hand to other trains of thought."

Artists and creative writers usually tend to engage in intentional daydreaming, thus intentional mind wandering could be a characteristic of creative work. A recent study investigated the different contributions of spontaneous and deliberate mind wandering on divergent thinking and creative achievement (Agnoli et al., 2018). In this study, participants reported their everyday deliberate and spontaneous mind wandering using two 7-point Likert-type scales respectively. The results revealed that deliberate mind wandering positively predicted originality, whereas spontaneous mind wandering was negatively related to originality.

However, there is other evidence that supports the idea that spontaneous mind wandering might be related to creative thinking. A research study indicated that spontaneous mind wandering has a distinct relationship with ADHD (attention-deficit/hyperactivity disorder), where individuals with more symptoms associated with ADHD reported more spontaneous mind wandering than deliberate mind wandering (Seli et al., 2015). The researchers also found that adults with ADHD generate more original ideas on verbal creative tasks and have higher levels of real-world creative achievement. Therefore, it is possible that spontaneous mind wandering may play a role in creative ideation.

Why Does Mind Wandering Affect Creativity?

The above research provides both behavioral and neuroscientific evidence supporting the idea that mind wandering may facilitate creative problem solving. Despite that, the underlying mechanism of this relationship is not yet clear.

Several researchers suggest that mind wandering may amplify the incubation effect in creativity. One possible explanation is that mind wandering gives more room to unconscious processing. According to the Explicit-Implicit Interaction (EII) model of creative thinking (Helie and Sun, 2010), incubation involves unconscious and implicit associative processes that demand little attention capacity, rather than conscious, explicit, and rule-governed processes. This may in turn stimulate remote activation in semantic networks during an incubation period, and could thus improve later creative performance (Baird et al., 2012), as predicted by the spreading-activation account of incubation. At the neural level, a large amount of research has shown that mind wandering and creativity are both linked to the default network, incorporating the posterior cingulate cortex, the medial prefrontal cortex, the inferior parietal lobule, and the medial temporal lobes. Default network activation is most strongly associated with thought that is both task unrelated and stimulus independent, as mind wandering is commonly described. It was revealed that the default network plays a critical role in creativity, and researchers have temporally mapped brain activity during creative idea production and found default network activation during all stages of the task (Beatty et al., 2015).

On the other hand, the positive relationship between deliberate mind wandering and creativity suggests that controlling and monitoring processes are essential to creative thinking to some extent. Recent research has found that deliberate mind wandering is correlated with regions in both default mode and frontoparietal networks (Golchert et al., 2017). Mind wandering is now considered a dynamic mental state, with interactions of frontoparietal control, default mode, and salience network, which may be conducive to incubation. The dynamic state of mind wandering may minimize the costs of attentional lapses and improve creative performance (Leszczynski et al., 2017).

In addition, mind wandering is also related to an individual's personal goals and concerns, and contributes to planning and preparing for the future. Baird et al. (2011) tested whether mind wandering had a potential function of autobiographical planning. Their results revealed that the temporal focus of participants' thoughts was predominately future-focused when they were mind wandering, which means their mind wandering was primarily prospective. Furthermore, results found that goal-directed thought and self-related thought were more frequently future-focused than present-focused or past-focused. A meta-analysis study found that episodic future thinking and mind wandering have similar patterns of brain activation (Stawarczyk and D'Armentau, 2015). In addition, many neuroimaging studies have shown that the activation of the default network is associated with several other forms of self-generated thought besides mind wandering, including mental simulation, episodic memories, and future-focused thinking. At the same time, there is a lot of evidence suggesting that episodic future thinking has a positive effect on creativity. Thus, in this vein, episodic future thinking may be a possible explanation for why mind wandering has a positive impact on creativity.

Despite this evidence, several studies suggest that mind wandering during creative activities may actually impair the task performance (Hao et al., 2015). Creative idea generation is now recognized as a top-down control process, as the *Controlled-Attention theory* indicated (Beatty et al., 2014). Based on the *Executive-Control Theory*, if mind wandering consumed the control resources, it would drive individuals from current tasks and environments to their internal thinking, which would lead to performance deterioration by competing for executive resources. Creative ideation needs a large amount of control resources to maintain attention, and inhibit the interference of old ideas and external stimuli, so mind wandering was able to occupy the cognitive resources, and impair creative performance.

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Relevant Website

Mind Wandering (<https://labs.psych.ucsb.edu/schooler/jonathan/research/mind-wandering>).

Mindfulness

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Introduction to Mindfulness

Mindfulness refers to “*the awareness that arises from paying attention in a particular way: on purpose, in the present moment, and non-judgmentally*” (Kabat-Zinn, 1994, p.4). This complex, multifaceted definition of mindfulness underlines three important attributes of mindfulness, which are the regulation of the focus of attention, the present (i.e., the “here and now”) as the focus of attention, and the attitude of openness and acceptance to the experience (Shapiro et al., 2006). According to Shapiro et al. (2006) the three components of mindfulness (intentionality, attention, and attitude) contribute to generate a “*fundamental shift in perspective*”: in the state of mindfulness, the individual engages in a clear observation of his or her moment-to-moment experience (e.g., thoughts, emotions, and bodily sensations), without reacting or judging it, with curiosity and nonattachment, being able to detach the contents of their thoughts and feeling from the self (“standing back” or “reperceiving” in Shapiro et al., 2006).

Mindfulness originally stems from Buddhist meditation traditions, which suggest that mindfulness as a state can be enhanced through an intentional regular practice of meditation (Lutz et al., 2007) and through structured mindfulness-based interventions (MBIs) that allow individuals to intentionally introduce mindful practices into their daily lives. Although there are different meditation practices (e.g., focused-attention meditation, open-monitoring meditation) and different MBIs (e.g., in clinical settings, mindfulness-based stress reduction (MBSR) program and mindfulness-based cognitive therapy (MBCT)), they all aim at helping people to “*become more aware of, and relate differently*” (Shapiro et al., 2006) to their experiences (including thoughts and feelings), instead of changing them.

Over the last two decades, mindfulness has become increasingly popular in the Western society receiving a great deal of attention in medicine, psychology, and neuroscience. This is illustrated by the dramatic rise in the number of studies on the effects of mindfulness meditation and structured MBIs on health and well-being, as well as on the cognitive changes resulting from practice of mindfulness meditation (Brown et al., 2015; see for a review, Tang et al., 2015). Globally, MBIs have been associated with a wealth of psychological benefits, ranging from a decrease of stress and distress and improvement of well-being and quality of life for people with chronic stress-related diseases, to improvement of symptoms specific of clinical disorders as depression, pain, anxiety, and addictive disorders (see for a review, Goldberg et al., 2018).

Neurocognitive studies on the effects of mindfulness meditation have also shown changes in multiple domains of mental functioning in both patients and healthy population: for example, mindfulness is reported to be associated with a better executive functioning (e.g., conflict monitoring) and selective attention abilities (e.g., orienting), with improvement in emotion regulation, decrease in emotional reactivity, intensity and frequency of negative affect, and increases in positive mood states (see for a review Tang et al., 2015).

Recently, neuroimaging studies have begun to investigate the functional and structural neural changes occurring in multiple brain regions in association with mindfulness meditation, raising the question of which underlying mechanisms support the positive impact of mindfulness on human psychological functioning. In this regard, as pointed out in a recent neurocognitive review on mindfulness meditation, “*there is emerging evidence that mindfulness meditation might cause neuroplastic changes in the structure and function of brain regions involved in regulation of attention, emotion and self-awareness*” (Tang et al., 2015, p. 222).

However, the question of “*how*” mindfulness works and the unique contribution of mindfulness compared to other interventions is still open and the interpretation of some results is made difficult by a number of methodological issues in the research area. One of the most relevant issues refers to the still relatively low number of longitudinal, randomized, and actively controlled research designs (i.e., designs with active interventions in control groups) in mindfulness studies. Some other issues are related to heterogeneity of interventions, in terms of practice duration and type of practice, as well as to the small sample size of participants.

Trait Mindfulness

As reviewed above, the majority of research on mindfulness has been focused on the investigation of the effects of mindfulness meditation and programs. However, another interesting contribution to our understanding of how mindfulness works has been recently provided by the empirical investigation of trait mindfulness (or dispositional mindfulness) which refers to the tendency to adopt a mindful perspective in daily life across situations and contexts. In this regard, several studies indicated that individuals strongly varied in their level of trait mindfulness, irrespective of mindfulness practice, although mindfulness meditation can enhance baseline dispositional mindfulness.

Understanding the relationship between trait mindfulness and psychological health and mental activity has important practical implications, for example, to shape individual-centered mindfulness interventions but to also promote mindfulness training as an intervention for those with low level of trait mindfulness (see Tomlinson et al., 2018). Research on this topic has been mainly conducted using self-report measures of mindfulness. Among the different instruments that vary in the breadth of mindfulness dimensions they assess, the two most commonly used are the Mindful Attention Awareness Scale (MAAS; Brown and Ryan, 2003) and the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006). The MAAS is a unidimensional 15-item questionnaire, assessing the attentional aspect of trait mindfulness. The FFMQ is a 39-item questionnaire, derived from a factor analysis of five previously developed mindfulness measures designed to capture the diverse components of the multidimensional construct of mindfulness and to measure them separately. Specifically, FFMQ allows to assess five facets of mindfulness, namely the ability to observe and attend to different internal and external stimuli (Observing); the ability to focus attention with full awareness (Acting with Awareness); the ability to express experiences, thoughts, and emotions with words (Describing); the ability to not react to feelings, emotions, and thoughts (Nonreactivity); and the ability to not judge and rate thoughts, feelings, and emotions as good or bad (Not-judging).

Higher levels of trait mindfulness, as measured by MAAS, were found to be associated with higher levels of the personality traits of agreeableness (a tendency to be sympathetic and affectionate), and conscientiousness (a tendency to be thorough and deliberate), and with lower levels of neuroticism (e.g., Brown and Ryan, 2003). In line with the findings on the effects of mindfulness interventions on psychological health, trait mindfulness, as measured by MAAS, was also positively associated with measures of psychological well-being and negatively associated with depressive symptoms, anxiety, and eating pathology (see Tomlinson et al., 2018).

The adoption of a multidimensional approach in the assessment of trait mindfulness, using FFMQ, has recently contributed to further clarify the relationships between trait mindfulness and other psychological variables and to understand the hidden mechanisms by which mindfulness can lead to positive changes. For example, longitudinal studies have shown that not all components of trait mindfulness have the same influence on psychological health and suggest a substantial role of the “Not-judging” facet in the prediction of several mental health outcomes, particularly depressive symptoms (e.g., Barnes and Lynn, 2010).

In a similar vein, cross-sectional studies on the association between trait mindfulness and psychological well-being found that the two facets of mindfulness —“Acting with Awareness” and “Not-judging”— were positively related to well-being (e.g., Short et al., 2016). Moreover, comparisons between meditators and nonmeditators revealed different patterns of association between the “Observing” facet and measures of psychological health: in meditators the ability to notice and attend to internal and external experiences (i.e., “Observing”) was positively associated with adaptive characteristics (e.g., openness to experience and emotional intelligence), and negatively associated with maladaptive characteristics (e.g., alexithymia, thought suppression, rumination, worry, and dissociation), whereas in both healthy and clinical groups of nonmeditators, this dimension was modestly but positively correlated with several maladaptive constructs (e.g., thought suppression) (e.g., Baer et al., 2006) and it was a predictor of depressive symptoms (e.g., Barnes and Lynn, 2010).

Despite several methodological limitations of some of these studies (e.g., small sample size; lack of assessment of meditation practice; and heterogeneity of designs and measures), these results on trait mindfulness clearly show the importance of adopting a multi-dimensional perspective (which “aspects” of mindfulness are being examined) and also suggest that a specific mindfulness facet might work differently in a different “context”. In the case of “Observing”, a tendency to a close observation of internal and external experience may be adaptive or maladaptive depending on whether it is done with an accepting, nonjudging, and nonre-active modality. The adoption of a multidimensional approach seems to be very helpful also in understanding the complex association between mindfulness and creativity. This approach is, however, only one of the several approaches that can be found in the literature exploring the mindfulness–creativity link.

Mindfulness and Creativity

Over the last few years, increasing interest has been devoted to the investigation of the association between mindfulness and creativity. According to Langer, mindfulness is intrinsically inseparable from creativity because mindfulness requires the creation of new categories in order to organize awareness of the complex world (Moldoveanu and Langer, 2011). According to this approach, mindfulness is characterized by an active generation of categories or making distinctions, which are core elements in the emerging of novelty. Mindful people are situated in the present and directed toward the future, constantly aware of the ongoing situation. In the exact opposite of the mindfulness concept, this approach places mindlessness, a phenomenon that is instead overdetermined by the past. Given this intrinsic relationship between creativity and mindfulness, this approach exploits creative activities to increase

mindfulness. In this regard, evidence has been provided demonstrating that the creation of art, such as drawing an object, is able to initiate the mindful process as well as to increase mindfulness (e.g., [Grant et al., 2004](#)).

On the one hand, there are theoretical approaches that hardly distinguish between the two constructs; on the other hand, recent findings showed the relative independence of creativity and mindfulness. Hence, whereas convincing evidence for a relationship between creativity and mindfulness emerges from the literature, the nature and the strength of this association as well as the main psychological mechanisms defining this relationship are still unclear and debated.

Looking at the literature, two different approaches have been adopted in the study of this association. According to the first one, mindfulness is investigated as a unitary construct, resulting in a *uniform analysis* of its association with creativity. The second approach investigates mindfulness as a multidimensional construct, resulting in a *differential analysis* of the strength and directions of the associations between the (trait) mindfulness subcomponents and creativity. The following section will briefly describe these two approaches.

Uniform Analysis

Considering mindfulness as a unitary construct has proven to be particularly useful when the role of intervention (i.e., training) protocols is explored in association with convergent or divergent thinking. Within this approach, also the differences between expert meditators and novices are taken into account. Mindfulness is therefore considered as a complex practice that can affect a number of cognitive processes, including creative thinking.

Starting from a biological perspective, recent research explored whether the effect of mindfulness on creative thinking could be associated with an activation of the default mode network (DMN). DMN, also called “intrinsic network,” is a large-scale network including medial prefrontal cortex, inferior parietal lobule, posterior cingulate/precuneus, and the medial temporal lobe, which has been recently highly explored in association with creative thinking. DMN is related to intrinsically oriented functions and actions, such as autobiographical processes or planning future actions.

A recent study by [Berkovich-Ohana et al. \(2017\)](#) indicated that expert meditators in comparison to short-term mindfulness practitioners exhibited a greater fluency in a divergent thinking task and a concomitant reduced activation in DMN during a resting state. These findings seem to contrast with a series of consistent results showing an active involvement of DMN in creative behavior (e.g., [Beaty et al., 2018](#)), but they call for further studies in order to explore the association between large brain networks, mindfulness, and creativity. Exploring whether individual differences in trait mindfulness could act as moderator of the role of DMN over creative performance is in particular a topic for future research. Moreover, it would be particularly interesting to understand whether the inhibitory control exerted by expert meditators over DMN activity during a resting state, as emerged in the study by [Berkovich-Ohana et al. \(2017\)](#), has a direct impact on the intrinsically oriented functions (e.g., imagination) related to the generation of creative ideas.

In recent years, a series of studies explored the association of trait mindfulness and the impact of mindfulness training on convergent thinking, and specifically on the ability to solve insight problems. Insight problems are those in which the use of past experience or previous knowledge leads to an impasse that can be solved only through a full restructuring of the problem. In this regard it is worth highlighting that one of the aims of mindfulness meditation training is to reduce the role of past experience by decreasing the impact of habits on the way we act on and react to the world (i.e., generating the condition of a “beginner’s mind”).

Given this main characteristic of mindfulness, [Ostafin and Kassman \(2012\)](#) tested whether mindfulness might facilitate solving insight problems (comparing the performance in a series of insight and noninsight problems). The authors found that trait mindfulness predicted better insight but not noninsight problem-solving (which do not require the overcoming of habitual responses) and that mindfulness training could improve insight but not noninsight problem-solving. Similarly, [Greenberg et al. \(2012\)](#) evaluated cognitive rigidity in experienced mindfulness meditators and nonmeditators (Study 1) and in nonmeditators undergoing an 8-session meeting mindfulness program and a waiting list group (Study 2). The results of these studies showed that mindfulness could reduce cognitive rigidity leading to higher probability to find novel solutions to given problems. Again, the authors concluded that mindfulness reduces cognitive rigidity because it is able to induce a “beginner’s mind,” and immunizes individuals from being “blinded” to new solutions by past experience.

However, a more specific analysis on the strategies used to solve insight problems suggested that mindfulness can act differently on the diverse modalities used to solve insight problems. Two main routes have been identified as associated with the ability to find solutions to insight problems: insight and analytic problem-solving. Whereas insight is defined as the sudden realization of a novel solution or idea through the unaware spreading of activation in the semantic memory and the recombination of the existing information, the analytic strategy is related to the deliberate search for the solution which involves the aware control of the incremental progressions in the process through the conscious reasoning and the rejecting of wrong solutions.

[Zedelius and Schooler \(2015\)](#) demonstrated that individual differences in mindfulness (as measured by MAAS) have a different impact on the two problem-solving approaches, namely, insight and analytic problem-solving. Specifically, a greater tendency toward mindfulness increased problem-solving when problems were approached in an analytic way, whether this strategy was adopted spontaneously (Study 1) or instructed (Study 2). In contrast, a higher tendency toward mindfulness impaired problem-solving performance when problems were approached in an insightful way, whether spontaneously or through instructions. These results indicate that mindfulness impairs performance relying on intuitive thinking, while it enhances the performance that relies on aware control of the thinking process. The apparently contradictory results on problem-solving indicate that mindfulness does not

have a unitary beneficial effect on creative performance. These findings emphasize the necessity of a more complex approach highlighting some important distinctions in the relationship between mindfulness and insight.

Differential Analysis

In order to unravel the apparently complex relationship between creativity and mindfulness, a series of studies have taken into account the multifaceted nature of both constructs. Colzato et al. (2012) explored how different types of meditation techniques were associated with diverse creative thinking components. Specifically, the authors investigated the impact of focused-attention (FA) meditation and open-monitoring (OM) meditation, which represent two of the main techniques in Buddhist meditation, on convergent and divergent thinking. In FA the meditator focuses on a particular item or thought, actively ignoring everything else that can attract attention by redirecting attention back to the task focus. In OM meditation the meditator is free to observe or focus attention on everything she/he feels or thinks without a specific attention on a concept in the mind or a fixed item. The results of the study showed that practicing OM meditation (targeting the Observing component of mindfulness), but not FA meditation (targeting Acting with Awareness component), was beneficial for subsequent performance in a divergent thinking task (i.e., alternate uses task, AUT) but not in convergent thinking task (i.e., Remote Associates Task). The authors suggested that the benefits of OM meditation arise from a reduction in the degree of top-down control and local competition, thereby leading to a broader distribution of potential resources, which facilitates jumping from one thought to another—as required in divergent thinking tasks. More generally, these results highlight the theoretical impracticability in sustaining a unitary effect of mindfulness on creative behavior.

In a four-study work, Baas et al. (2014) directly tested the two competing approaches, namely, the uniform versus the differential impact of mindfulness on creativity (as assessed through divergent thinking tasks and self-assessment measures of creative attitudes and creative achievement). In these studies, mindfulness skills were measured (Study 1–4), extensively trained (Study 3), or manipulated with a short meditation session (Study 4). The results emerging from these studies supported the differential approach, clearly demonstrating that the association between mindfulness and creativity depends on the specific mindfulness component involved. In particular, this research showed that over the measured mindfulness skills only Observation was constantly able to predict enhanced creativity. Specifically, an increase of Observation induced through an 8-week mindfulness training was associated with increased creative tendencies. In addition, a manipulation of the Observation skill induced more original ideas in divergent thinking tasks.

Baas et al. (2014) demonstrated that this positive and strong link between Observation and creativity was partially mediated by the positive association between Observation and flexible thinking, a cognitive mechanism that past research already demonstrated to be an essential driver for creativity. Since flexibility only partially mediated the relationship between Observation and creativity, the authors proposed other explanatory mechanisms linking these two constructs. First of all, the authors proposed that openness to experience could put Observation and creativity in relation, since this trait strongly related to Observation and it is one of the most robust predictors of creativity. Moreover, since Observation is usually associated with the ability to efficiently recruit relevant information from the inner and the external world, creativity might benefit from this ability because of its strong dependence from the individual's skill to retrieve information from long-term memory and from the outside world. All in all, the results of this study confirmed the findings of Colzato et al. (2012), highlighting that Observation is the component of mindfulness that more strongly and consistently is associated with creativity.

Lebuda et al. (2015) carried out a meta-analysis on 20 studies (20 independent samples and 89 correlations obtained in a total sample of 1549 participants) exploring the relationship between the different mindfulness skills and different creativity measures. The analysis revealed that mindfulness and creativity are significantly related, with a small-to-medium effect size. As the author pointed out: "Although this effect was not moderated by the design of the studies, it tended to be stronger when creativity measurement had the form of insight tasks rather than divergent thinking tasks" (p. 24). The relationship was consistent across the different measures of mindfulness, but it resulted significantly lower when the mindfulness measurement method or the research aim were concerned only with the awareness dimension. This analysis confirmed past research showing that the relationship between creativity and this attention-based mindset (i.e., Awareness) is significantly weaker than in the case of other mindfulness dimensions. Interestingly, this meta-analysis registered no significant differences in the effects that emerged between correlational and experimental studies, showing not only that mindfulness and creativity correlate with each other but that enhancing mindfulness through meditation increases creativity as well. This result suggests that between mindfulness and creativity there is not only a correlational link, but also a causative effect. As the authors discussed, these findings have important consequences for the education of creativity, suggesting a beneficial effect of MBIs targeting specific mindfulness skills (e.g., intervention based on OM meditation).

Conclusion: Toward a Multidimensional Conceptualization of the Mindfulness–Creativity Link

Current research trends in the scientific literature are highlighting the need for a multidimensional approach in the study of both mindfulness and creativity. Approaching the study of these two constructs using a multifocal lens can allow one to disentangle the role of specific cognitive and attitudinal mechanisms over the creative thinking process, as well as to program *ad hoc* training interventions on specific mindfulness dimensions. It is clear that the multidimensional approach entails a higher level of complexity. This approach in particular leads to two orders of questions: (a) Since mindfulness does not happen in a *vacuum*, how does its

dimensions interact with other attitudinal/cognitive states in influencing creativity? In other words, since creative thinking is determined and associated with a *plethora* of individual differences (e.g., openness to experience, motivation, self-efficacy, etc.), research should pay particular attention to the interaction of the diverse mindfulness constituents with other individual differences and with the interfering role of other cognitive/emotional states and activities; (b) the second order of questions are related to the temporal dynamics in the interaction between mindfulness and creative thinking: Do the distinct mindfulness skills influence creative thinking differently depending on the stages defining this thinking process?

Evidence has emerged in the literature addressing these two types of questions. For instance, the interactive role of the tendency toward mindfulness and mind-wandering on creative performance (idea originality in a divergent thinking task) and creative achievement has been investigated in a recent study (Agnoli et al., 2018). Even if these two mental states have been traditionally intended as two antithetical constructs, their exploration in association with creativity has been addressed in this study using a multi-dimensional approach, distinguishing between the five mindfulness dimensions and between deliberate and spontaneous mind-wandering.

The results of this study highlighted that different mindfulness dimensions predicted creative performance and creative achievement both alone and in association with the two types of mind-wandering. These findings showed that mind-wandering and mindfulness are not mutually exclusive dimensions; rather, when explored as multidimensional constructs, they can interact in explaining the creative behavior.

This study showed that, when originality and creative achievement were jointly explored in a single statistical model as dependent variables, the Nonreactivity facet of mindfulness was negatively associated with the ability to produce original responses in a divergent thinking task, while the Describing facet predicted directly creative achievement. The ability to Nonreact to inner experiences emerged therefore to be detrimental for the production of original ideas. This finding could be related to the fact that Nonreacting to the emotional activation produced by internal feelings could block the beneficial effects brought by emotions in the production and selection of original ideas. The ability to Describe feelings and beliefs with words emerged instead as a direct predictor of creative achievement, showing that the ability to bring complex and original concepts from the internal to the external world is an essential skill to achieve creative success in real life. This result partially resembled the result by Baas et al. (2014), showing that the Description skills positively predicted increases in self-assessed creative behavior but not in creative performance. The direct effects of single mindfulness facets were combined in this study with interactions with the two mind-wandering dimensions. For instance, deliberate mind-wandering interacted with the Awareness facet of mindfulness in the prediction of originality. Specifically, high levels of originality were associated with high levels of deliberate mind-wandering, which interacted with the Awareness facet. According to the authors, this result might suggest that the ability to generate creative ideas is related both to a propensity to deliberately think beyond immediately relevant concepts and with a high tendency to reconnect with full awareness to the initial creative focus, which is needed to generate not only original but also effective ideas.

These findings highlighted the complex interactions between individual mindfulness attitudes and other personality or attitudinal differences. The multidimensional approach to the study of the mindfulness–creativity link was characterized by some inconsistency in results, in particular, on the role of the single mindfulness dimensions on creative performance. On the one hand, the different methodological approaches and research designs used in the literature to measure both mindfulness dimensions and creative performance should be taken into account. This could be a first source of confusion in the interpretation and comparison of the findings. On the other hand, it is worth highlighting that some results emerged as particularly consistent: the Observation facet emerged as especially important in relation to creativity, whereas the Accept with Judgment hardly emerged to be associated with the creative behavior.

Finally, interactive effects between the variables explored in the different studies should be considered when interpreting and comparing findings. A clear example of the importance of taking into consideration interactive effects are the results on the Awareness dimension emerged in the study by Agnoli et al. (2018): consistent with past research (see Lebudá et al., 2015) no direct effect of Awareness on creative behavior was shown in the study; however, this dimension emerged as particularly meaningful when explored in relation to mind-wandering tendencies. Future meta-analytic studies are therefore needed to measure interactive effects when analyzing the mindfulness–creativity link.

Lebudá et al. (2015) suggested that “It is likely that different aspects of mindfulness, such as open-monitoring abilities and awareness, play a role at different stages of the creative process” (p. 25). This reflection opens new degrees of complexity as well as new paths for future research. Not only could the different mindfulness dimensions have a different impact on creative thinking, but they could also impact the different stages of the creative thinking process in a different way. Most of the literature on the link between mindfulness and creative behavior has focused on the ideational state of the creative thinking process. It is worth highlighting that idea generation (i.e., ideation) is only a part of the multifaceted creative thinking process and a systematic exploration of the role of the mindfulness dimensions on different stages of the process has never been performed. Taking into account, for instance, Mumford’s model of the creative thinking process (Mumford et al., 1991), it would be fascinating exploring how the diverse mindfulness dimensions can influence the initial definition of the creative problem, the following information gathering and organization, the conceptual combination that precedes idea generation, the final idea evaluation/selection, as well as the idea implementation and monitoring. Mindfulness could indeed have a main importance in the establishment of initial motivational drives guiding the entire process as well as in the selection from memory, through inhibitory/excitatory mechanisms, of the information used to generate new ideas. By adopting such a perspective, it is clear that the research so far has explored only a drop in the ocean of the real possible areas of investigation of the mindfulness–creativity link. This realization sets a call for research actions

exploring the relationship between mindfulness and creativity, starting from the fundamental assumption of the multidimensional structure of the two explored constructs.

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Mindset and Einstellung Effect

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Introduction

Mindset is a collection of hypothesis, ideas, or assumptions held by an individual or group at a specific time. When these form an expectation towards a stimulus or problem, this is known as the Einstellung Effect.

This expectation can sometimes help problem solving and other times hinder it. Studies at the individual level focus mainly on the instances in which the Mindset is impeding the process of finding a solution (i.e., when the previous knowledge is no longer useful). In recent decades Mindset has also been studied as part of an executive function domain. There it is often referred to as the task-set that hinders the shift to solving a new task.

This entry will briefly describe a history of the terms. Then the Einstellung Effect will be discussed within the context of stimulus perception and as part of problem solving. The text will conclude with Mindset and Einstellung effect's relation to creativity and insight.

History of the Terms

Einstellung and Einstellung Effect are often traced back to Luchins' (1942) monograph. There "the habituation to the repeatedly used procedure [...] is [...] called an *Einstellung*" (p. 3, italicization in original). Furthermore, Luchins' paper defined "Einstellung problems" which may generate an 'Einstellung Effect' for the subsequent 'critical test problems', which, if the Einstellung operated, would be solved in the Einstellung method [...] and not in the more simple and direct fashion." In other words, the Einstellung Effect causes participants to solve problems in a potentially more difficult way as they repeat a previously learned solution.

These solutions can be trained through habituation. Luchins (1942) suggested a specific type of problems to test habituation: similar paths offer solutions to all problems with the subset of critical test problems offering additional and more straightforward solutions. Luchins' referred to Warren (1934) who described Einstellung as "the set which immediately predisposes an organism to one type of motor or conscious act." Later, Luchins (1942) gave more details by defining "Einstellung—habituation—as a mechanized state of mind, a blind attitude towards problems; one does not look at the problem on its own merits but is led by a mechanical application of a used method (p. 15)."

The context of Luchins' (1942) publication is interesting, as it ties closely to the Berlin School of Gestalt Psychology. Luchins referred to Norman Maier's work in mentioning 'some preliminary experiments' by Zener and Duncker with a similar setup. Abraham Luchins studied with Max Wertheimer in New York and became a close collaborator. Wertheimer himself was one of the founding fathers of Gestalt Psychology who fled to the USA from Nazi society in Germany. As one of the leading Gestalt Psychologists, Wertheimer was interested in effects such as insight as the moment of understanding the overarching Gestalt of a stimulus. In particular, he argued, only insight-based reasoning can solve conceptual problems. He expressed this in his seminal work 'Productive Thinking' and taught it at The New School in New York. Through his direct mentorship, Wertheimer's approach to problem-solving probably influenced Luchins work (see "Insight").

Further tracing the origin of Einstellung in another direction, Warren (1934) listed three possible interpretations of the term in his dictionary. The first is a predispositional 'set' towards a specific activity and shows great similarity with how Luchins used the term later. The second description shows a tendency towards a renewal of neural functions and references the work of Georg Elias Müller. The reference is to his work on 'psychophysics' and supposedly not Einstellung since Müller worked as an experimental psychologist in the 1870s. Finally, the third definition described readiness for monotonous work. While an explicit reference is missing, Warren's entry contrasts Einstellung as an unconscious process with 'Aufgabe' which he described as conscious and the cause of Einstellung. Therefore, this third interpretation is different from the contemporary understanding of the term. Interestingly, Warren (1934) listed another term 'determining tendency' as 'somewhat more specific than Einstellung' and suggested the work of Narziß Ach as a source for it.

Ach (1905) wrote about Einstellung more elaborately than ‘determining tendencies’ (orig.: ‘determinierende Tendenzen’). Specifically, he listed five different types of ‘sensory Einstellung’ (orig.: ‘sensorielle Einstellungsformen’) and additionally four ‘muscular Einstellung’ (orig.: ‘muskuläre Einstellungsformen,’ referring to the motoric system). Ach extracted these nine types of Einstellung from his experiments and observations. He discussed some of the forms and their relationship to observations by his colleagues.

In Ach’s text, written in German, the term Einstellung appears to be partially used as a technical term and partially as an everyday term. Furthermore, there are no explicit references to other publications to define Einstellung as a technical term. This missing reference suggests that Einstellung might have been a commonly used term in the circles around the developing Gestalt school in Würzburg and Berlin, as well as Wundt’s laboratory in Leipzig. In this case, the development of the term might have been a shared effort between the protagonists of early experimental psychology. Another interpretation would be that Ach (1905) was the source of Einstellung as a technical term, as he described each of the nine types in great detail.

In recent approaches, Bilalić et al. (2008) discussed Einstellung in the context of problem solving and equated it to the “negative impact of previous knowledge.” However, the relationship with problem solving is not that simple: The Einstellung can also have positive outcomes, and so-called “super experts” can easily overcome it.

Consider the other term of this entry, Mindset. There is no direct connection between the two terms, Einstellung and Mindset in Luchins’ (1942) work. Nonetheless, he mentions ‘set’ and references Gibson’s (1941) extensive publication on the history of ‘set.’ Gibson, however, who later went on to develop the theory of affordances, does not mention Mindset directly. Historically, he traces the term ‘set’ to the Würzburg Gestalt school use of Einstellung while admitting that the term has only been loosely defined. To illustrate this, Gibson listed 15 different types of sets, followed by 14 closely related terms – but Mindset is not one of them. Furthermore, he listed how often ‘set’ had been applied, among others, to different effects like the incubation process in reasoning, only partially seeing a problem and sensory hallucination. Gibson referred to Warren’s (1934) dictionary as another source, but there ‘set’ is described through synonyms like Einstellung and disposition, without explicitly mentioning Mindset. Gollwitzer, who used the term ‘mindset’ and ‘mind-set’ extensively in his publications, did not always provide an origin or definition for the term. Nevertheless, in one of his earlier publications, he seemed to use ‘mind-set’ as a direct translation of the term Einstellung (Gollwitzer 1990, p. 63). This is one of the earliest publications using Mindset as a technical term. Consequently, the term Mindset has only been used for roughly 30 years, while ‘set’ reaches back further, possibly even before Warren’s (1934) dictionary. Across all these publications, the terms ‘set’ and Mindset are consistently described as synonyms for Einstellung, for example as defined by Warren (1934): ‘set/mental = a condition of readiness for some specific type of mental performance — Ger. *Einstellung*’. Consequently, Einstellung and Mindset are two terms describing the same phenomenon. After the antecedent compilation tracing the historical origin of the terms, the following sections will describe research investigating the actual effects.

Mindset and Einstellung Effect in Problem Solving

To explore the Einstellung Effect, Luchins (1942) observed human problem-solving skills. In their experiments, Edith and Abraham Luchins asked participants to measure a certain amount of water. Three containers of defined size were given for each task with the goal to arrive at a specified amount of water at the end. For example, if given a 29 and a 3 unit sized jar, to arrive at 20, participants could solve the problem by scooping the smaller jar three times from the filled bigger one.

The experiment started with moving water between jars to demonstrate the task. This demonstration was followed by five tasks which could all be solved similarly. Namely, the solution required to move water from the first jar to second and then subtracting two more of the third jar from it. Representing the jars through A-C and the solution by S, the solution to the first five tasks was $B - A - 2C = S$. These tasks were followed by four more, which could be solved in the same way, or by doing just a simple step of either adding or removing water once. While the solution $B - A - 2C = S$ would still work, the more straightforward solution would equate to $A + C = S$ or $A - C = S$ and require participants to start with another jar than B.

The majority of participants who engaged in the first five tasks did not change to a more straightforward solution. Instead, they solved the remaining problems by starting with B. Participants who only saw the latter problems, were able to solve them, starting with A, which shows it is not a matter of task difficulty. These results showed that participants tended to use the same strategy they applied to previous tasks for the final four tasks as well. Presumably, they ‘set their mind’ to a particular strategy and learned a specific solution throughout the performance of the tasks. As a result, they had formed some expectation toward the nature of the problem and how it could be solved. Since the longer path still leads to a solution, the Mindset from the first tasks was kept intact.

The Einstellung effect has had negative connotations since the initial description, such as ‘blind attitude towards problems’ and Luchins (1942) elaboration on the negative emotions that his participants conveyed through their comments. Furthermore, and contrasting it with the *Sequence effect* coined by Hull in the 1920s, the Einstellung effect has since been described as the negative aspect of transferring knowledge (cf. Sweller, 1980). Conversely, a certain Mindset and hence the ‘habituation to the repeatedly used procedure’ allows quick and effortless problem solving when ‘surface features’ and ‘abstract solution structures’ remain the same across tasks. In this case, participants benefit from the sequence effect by applying previously learned solution paths to similar or analogous problems. Already Luchins (1942, p. 93) mentioned the positive aspect of speedy responses to recurring situations and suggested, that this would ‘free the mind [...] to ...] deal with complicated tasks’.

On a functional level, finding the solution is then more of a memory recall than investing energy into finding a novel solution to a problem. On the other hand, if the ‘surface features’ remain similar while the underlying ‘abstract solution structure’ has changed, applying the same solution path can have two possible outcomes. Firstly, if the previously learned path does not yield a solution, this might trigger a new problem solving process, possibly involving an impasse due to similar surface features. Secondly, if the problem can be solved using the same solution path despite a possibly easier solution, this is referred to as the Einstellung effect.

Referring back to the water jar problem and framing it as an optimization problem, shortening the solution path by two water movements might look like a notable improvement. Consequently, and mediated through the Einstellung effect, ignoring the shorter solution appears like a waste of resources, especially considering theories along the lines of the free-energy principle. However, keep in mind that Luchins (1942) administered the tasks as a pen-and-paper experiment. The difference in time and energy investment between executing a four-step solution and a one-step solution was minimal for the participants. Hence, recalling a working and known solution was arguably the faster and more energy-efficient solution. The results by Vallée-Tourangeau et al. (2011), who asked participants to move water in addition to the pen-and-paper solutions, support this argument.

From the initial experiments on, Mindset can be observed in the context of learning as well. Participants in the Luchins experiment learned how to solve a specific type of problem and once learned it was easier and arguably more energy efficient for them to apply the process to seemingly similar problems. In a sense, these participants who repeated a previously learned experience reacted less to a particular and novel stimulus, but rather to their representation of seemingly similar problems. The clinical conditions of perseveration, for example, described by Sandson and Albert (1984), take this to the extreme. Here specific behavior and reactions were initially learned or triggered by stimuli, yet in the case of diagnosed perseveration, the absence of stimuli produced the same behaviors. Sandson and Albert (1984, p. 715) summarised previously published classifications, and suggested that these stuck-in-set perseverations are based on an ‘underlying process deficit in executive functioning.’ Having these extreme forms of Mindset linked to neuroanatomical features and deficits, one could argue that even perception is related to the Einstellung effect.

Whenever the set refers to a known function of a particular object that interferes with finding alternative uses of that object, this phenomenon is called functional fixedness (Adamson & Taylor, 1954). This effect is consistent across older children (from 6 years on), and adults too (Defeyter and German, 2003), but younger children before their fifth year do not exhibit this behavior. These findings imply that younger children do not yet know the functions of objects well and as such, they allow any intentional use to be an object’s function. Looking at all age groups, some argue that having the knowledge about objects functions impedes problem solving (i.e., leads to functional fixedness), others found that knowledge helps (Bilalic et al., 2008; Munoz-Rubke et al., 2018). For example, in the context of chess, Bilalic et al. (2008) found that up to a certain level of expertise the Einstellung effect is easily observed, but “super experts” are better in overcoming the functional fixedness of a known position and are more likely to find novel solutions. Thomas et al. (2018) demonstrated another example of the link between knowledge and Einstellung: For a magic trick, participants received a description of how the legerdemain worked. Nevertheless, this information seemed to trigger an Einstellung effect and fixated them on the wrong solution (see “Magic”). These two examples illustrate that the link between the knowledge base and the Einstellung effect are not well understood and possibly extend to other factors.

Einstellung also plays a vital role in research on executive function and attention. In this area, ‘set-shifting’ as one important executive function (Best et al., 2009) is explicitly linked to Mindset: The ability to shift, or to break the set, refers to the ability to change the rule or the task when solving a problem. In other words, the ability to shift attention efficiently reduces the Einstellung effect and results in not perseverating in the initial rule or task. Studied mainly with the task-switching paradigm, a plethora of studies showed that there is a switch cost immediately after a task switch, proving that the formation of a set does interfere with current problem solving. As such, attention shifting may be one core-specific mechanism that is involved when one needs to overcome the Einstellung or Mindset effect.

This section discussed Mindset in terms of higher-order cognition. The following section will explore how visual and auditory stimuli are perceived differently based on inner states by relating the Einstellung Effect to a range of perceptual tasks.

Mindset and Einstellung Effect in Perception

In addition to higher-order cognitive tasks and problem solving, other perceptual tasks expose characteristics of Mindset and the effect of Einstellung. This examination applies to the literal interpretation of Einstellung as an attitude towards a stimulus, as well as the definition developed following Luchins’s work. Notably, the mechanized states of mind towards visual and auditory stimuli influence how they are perceived. This entry puts forth the argument that the Mindset drives the understanding of a stimulus. This insight follows the general trajectory of cognition influencing perception ‘top-down.’ Einstellung has also been argued to have neural plasticity effects and would consequently have a long-term influence on bottom-up processing. As the Einstellung effect is often referred to as a short-time intervention, this section focuses on the top-down processes.

In their overview of top-down processes, Scocchia et al. (2014) discussed how visual stimuli and the visual system can be influenced using the example of multistable stimuli. In particular, the discussion on voluntary control and perceptual dominance relate to the Einstellung effect: Voluntary control describes the ability of people to influence the duration of holding a single interpretation of a multistable stimulus or influence the frequency of switching between different percepts. This voluntary switching behavior is known for the modality of visual perception as well as for auditory stimuli.

For the example of visual stimuli, Scocchia et al. (2014) referred to a rich history of experiments dating back as far as Helmholtz’ experiments in the 1850s where participants were instructed to hold one possible interpretation as long as possible or switch

between percepts. This top-down control on the perception in the visual system showed the influence of the participants' Mindset on perception. Another example of a Mindset for these stimuli utilizes perceptual dominance. [Scocchia et al. \(2014\)](#) discussed how the sequential presentation of stimuli resulted in the adaptation of the dominance of a specific interpretation. Further support for the influence of Einstellung on the perception comes from experiments where bistable stimuli are interleaved with blank periods, where the frequency of switching is slowed down significantly. [Scocchia et al.](#) explained this observation through the "dependency of current ambiguous perception from prior history of perceptual dominance" (p. 10), which seemingly refers to the mechanized state of mind derived from the likes of Luchin's definition of Einstellung.

For both cases, voluntary control and experiments relying on perceptual dominance, the viewer generates a switch between perceptions that is not visible in the stimulus itself. This relates to the extensive collection of visual illusions such as the Kanizsa triangle, where fragments of black circles with cut out slices create the illusion of a bright white triangle. Historically, the proponents of Gestalt psychology have collected illusions, where the people's prior knowledge and the arrangement of stimuli facilitate the perception.

This section referred to the Einstellung effect in the context of top-down influences, which was critically discussed, for example, by [Firestone and Scholl \(2015\)](#). Their claim 'cognition does not affect perception' seems to conflict with the arguments presented so far. However, even these critical readings of the literature acknowledge that attention, memory, and response biases influence the reaction to stimuli. Specifically, their conclusion appears to relate to the question at what level higher-order processes influence a reaction to stimuli. For the discussion of Mindset within this entry, the exact influence of higher-order functions on perception is irrelevant. That is, as long as there is any influence. Therefore, this particular argument by [Firestone and Scholl \(2015\)](#), along with the discussion in the open commentaries supports the existence of an Einstellung effect on perception.

The Relationship to Creativity and Insight

The seminal article by [Luchins \(1942\)](#) opened – as discussed earlier – with a reference work on insight in problem solving. In insight, the solution of the problem comes spontaneously in conscious thought, and often this requires going beyond known solutions. Because learned solutions form the Mindset, they can interfere with new solutions when the older ones instill a mental rut. Insight seems to be substantially involved in creative thought, with the latter being fundamental for innovation. The relationship between Mindset and insight is frequently presented to be negative: When the Mindset leads to a perseverative exploration of known paths for solving the problem (i.e., the Mindset is highly probable), insight cannot manifest itself (i.e., is less probable to occur). One explanation for this type of relationship may be the fact that while insight is based on restructuring both previous knowledge and the problem information, Mindset and more specifically the Einstellung effect usually implies going along known paths. Furthermore, the Mindset seems to block the way for originality, an essential requirement of creative thinking. As such, there is agreement that Mindset leads to rigidity of thought ([Schultz and Searleman, 2002](#)).

Recent results showed that successfully solving insight problems does not depend on the initial problem representation but on controlled processes of reasoning. Namely, the process of surpassing the Mindset by suddenly arriving at another viable solution seems not to be well understood so far and may be just another case of carefully but implicitly controlled reasoning. Just like for creativity where both convergent and divergent thinking are needed, studies investigating insight show that processes involved in the emergence of sudden AHA moments are very complex ([Rothmaler et al., 2017](#)).

Assuming creativity could be understood along the dimensions of usefulness and novelty, another discussion suggests itself. As discussed earlier and highlighted throughout the literature, Einstellung is useful and leads to useful behavior. Therefore, if Mindset is about the habituation of an attitude towards a stimulus, the Einstellung effect leads to anything but original behavior. Moreover, even if alternative solutions become easier, people with a certain Einstellung 'stubbornly' stick with their previously habituated solution path. Arguing from the experimenter's point of view, this defeats the definition of novelty. Instead, if taking a stance from the task's point of view, there are two different types: One task with only a single solution, and the other type with two solutions. The two solutions seem to exhibit different difficulties, as Luchins demonstrated through the control trial. The result of the experiment showed that people in the Einstellung condition chose to solve the second type of problems through their more difficult and less obvious solution. Taken by itself, this behavior could be considered original as it diverges from the normal behavior. In fact, in divergent thinking tasks answers are often scored independently from each other while the stimuli, as well as the narrative of the previously given answers, could result in a bias leading to more original solutions. Consider, for example, a participant who starts thinking about using a brick for artistic purposes, maybe for a modern architectural building, a statue, and an art installation. In this case and by transferring a context from one idea to another, the Mindset could lead to the highly original solution of grinding the brick to use its pigments as paint.

An extension of this idea of Einstellung as a mediator of knowledge between domains into real-world applications could be the contribution of researchers in interdisciplinary collaborations. While biased towards a particular set of tools, knowledge, and the underlying philosophy, the combination of Einstellung from each contributor leads to novel approaches that diverge from habituated solution paths. Further considering the similarity between Einstellung and biases, this would even have implications for science itself and the underlying philosophies ([Andersen et al., 2019](#)). Drawing together these two examples from divergent thinking tasks and interdisciplinary team science, the interaction between Einstellung and creativity are apparent. While it would be too superficial to consider Einstellung as an enabler for creativity, there is more to the relationship than meets the eye (see "Interdisciplinary Approaches to Creativity").

Final Thought

Is Einstellung a general effect for humans? Even if the cognitive set is implicitly considered to be specific to humankind, recent work suggests that culture and schooling have an influence. For instance, Pope et al. (2019) found that semi-nomadic Himba people are not affected by cognitive set in the same way as Western participants. Interestingly, Himba participants chose the novel shortcut more often than Westerners in a computerized ‘Learned Strategy — Direct Strategy’ task. Pope and her colleagues explained the results in terms of environmental uncertainty and educational background. Namely, they suggested that the environment of Himba people poses higher levels of uncertainty. Pope et al. (2019) also pointed out that the Himba education puts less emphasis on repetitions than western societies do in their school systems (see “Education and Creativity”). Thus, the question of Einstellung as a generalized phenomenon arises and asks for future clarifications.

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Moral Issues☆

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The Nature of Morals

In this chapter morals will be understood in the sense of normative ethics: a framework for working out which actions are virtuous and which are wicked (e.g., good as against bad, righteous as against unrighteous, or worthy of emulation as against unworthy). Creativity will be understood in the now familiar sense of production of relevant and effective novelty. The key questions underlying the chapter are: Can creativity be judged according to moral precepts? What makes creativity moral and when is it immoral? How can moral creativity be promoted?

Moral precepts are not physical laws or forces of nature, but are ideals that have been worked out by philosophers, religious authorities or other thinkers, although they may have demonstrated their worth in people's practical experience of life (as the evolutionary view of morals mentioned below particularly emphasizes). Morals are a matter of subjective internal conviction rather than concrete evidence or physical or even legal coercion. They often reflect the influence of religion or philosophy, culture, family and friends. Although there is obviously a connection between them, morality and law are not the same thing. Some actions are legal, but of dubious morality. On the other hand, some actions are illegal, but are regarded by many people as moral. Although moral transgressions may be punished by condemnation, rejection, public humiliation, or other external sanctions, they are also strongly enforced by internal sanctions such as pangs of conscience or feelings of shame. The truly moral person behaves in a moral way out of personal conviction.

Moral Behavior

A sister topic to morals is ethics: Ethics are concerned with how a moral person should behave. Ethical behavior involves doing what is morally right and proper, and not simply what is expedient. According to Marc Bekoff and Jessica Pierce, morals involve 'a suite of interrelated other-regarding behaviors that cultivate and regulate complex interactions within social groups.' This definition directs attention squarely to the social nature of morals and in particular to the central role of concern for the well-being of others (morals are other-regarding). Immanuel Kant argued that there is a 'moral imperative' to treat other people with dignity, and never to exploit them as instruments of one's own satisfaction. According to John Locke, no-one should act in such a way as to harm anyone else's life, health, liberty or possessions. For Locke, these were natural rights, given by God. Unfortunately, despite Locke's attribution of moral principles to God, people's ideas of what is right and proper are highly subjective, and often differ sharply from person to person, from society to society, and, indeed, from era to era; Galileo's publication of his (factually correct) thesis that the earth rotates around the sun (and not vice versa) was regarded in his own time as so morally reprehensible as to constitute heresy, and led to years of house arrest. Thus, being factually correct does not guarantee acceptance as morally or ethically good, especially where the facts contradict pre-existing fixed beliefs, as was the case with Galileo.

Nonetheless, some ethical values transcend cultural, religious, or ethnic differences, and thus involve something approaching a universal moral worldview. According to Plato, for instance, there are four 'cardinal' virtues (courage, temperance, prudence, and justice) which should guide all actions. All other virtues are thought to spring from these. Examples of widely accepted virtues

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are responsibility, fairness, concern about the well-being of others, good citizenship, integrity, sincerity, trustworthiness, generosity, and fortitude, all of which are mentioned by numerous writers in the area. Such writings are not confined to the Western, Aristotelian tradition. The Confucian construct of 'ren' is an example of a broad definition of what is right and good that is widely accepted in Asian countries and beyond. Ren can be translated as 'righteousness.' It includes moral virtues such as loyalty, consideration, conscientiousness, or altruism.

Morality and Creativity

When applied to creativity, questions of morality are initially centered on whether creativity can be judged in moral terms at all. Despite the conclusion of some writers such as Mark Runco that creativity or creative thinking processes are neither moral nor immoral in themselves, or even that creativity is above such considerations, Robert McLaren pointed out that creativity has come to have a 'quasi-religious function' in modern life, according to which it is widely regarded as the epitome of goodness. This spiritual tone was already present at the beginning of the modern creativity era: Jerome Bruner saw creativity as the last bastion of the admirable side of the human spirit in an age in which electronic devices are taking over many functions. Nowadays, creativity is frequently proposed as the human counter-thrust to the recent rise of cyber-physical systems in the sense of Industry 4.0, which really are beyond considerations of good and evil.

Discussions along these lines have not infrequently argued that creativity is a primal force of nature, and that it is, by definition, a universal beneficial factor fostering growth and rebuilding in all organic systems, and is thus automatically good. Brian Henning referred to it as 'the dynamic process of the universe.' According to Friedrich Nietzsche in his discussions of art and music and their relationship to aesthetics and ethics, they involve 'deification of existence.' In fact, research has shown that, almost without exception, the term creativity itself and all synonyms for it are still almost always used in a positive sense in modern psychological discussions.

Immoral Creativity

However, it is difficult to regard, for instance, the effectively novel systems for killing people in large numbers generated by Hitler or Stalin or the undoubtedly novel attack on the World Trade Center in 2001 as the same in principle as the works of, let us say, Shakespeare or Mozart. It is conceivable that the cognitive processes are similar in all four cases (for instance, generation of alternative ways of seeing things, linking of ideas usually kept separate, or branching out from the known in a new direction). However, apart from the differences in the nature of the products—works of art vs. technological and management systems—there is a clear difference in the products of the creativity of Hitler and Stalin vs. Shakespeare and Mozart; on the one hand, death and destruction for people not actively engaged in any directly hostile activity, on the other, things of beauty. Furthermore, and of central importance for this chapter, there were substantial difference in the intentions of the persons involved: on the one hand a desire to generate truth and beauty, on the other, a desire to do harm and wreak destruction for essentially political purposes. Paraphrasing Darcia Narvaez and Kellen Mrkva, moral creativity requires not only the ability to generate useful novel ideas, but also the ability to form ideas about what is good and right (and to do good).

The problems associated with morality in creativity are, to some degree at least, inherent in creativity itself. The essence of creativity is changing what currently exists. Among other things it:

- shakes the foundations of the received order and brings uncertainty for other people,
- questions the value of existing knowledge and skills (often laboriously acquired),
- threatens loss of status and authority for experts, leaders, or established creators,
- encourages dissatisfaction with the status quo, restlessness or rebellion,
- encourages putting your own needs and resolving your own dissatisfaction ahead of the needs of others.
- opens the door to dark and destructive material that needs to be handled with great caution (see below).

These processes can easily become destructive, especially if they are self-centered and self-serving, or are applied recklessly. They yield moral results only when they promote fairness, justice, good citizenship, altruism, and the like, rather than furthering the narrow self-interest of an individual or a special group. Thus, the seeds of immorality are inherent in the very nature of creativity.

Negative effects of creativity need not arise from deliberate malevolence. Some negative effects are very difficult or impossible to anticipate: the lifesaving discoveries of Louis Pasteur and Edward Jenner, for instance, laid the foundation for germ warfare. Some people may even create obviously immoral products despite generally having positive moral values and wishing to behave in an ethical manner. They may, for instance, consciously or sub-consciously blind themselves to the immoral consequences of their work, be unable to or unwilling to anticipate negative consequences, or succumb to temptation. This may occur, for instance because of their fascination with what they are doing, or because they are deceived or coerced by factors like the prospect of money and fame or the manipulation of a despotic government. Maria Zaitseva gives the example of how this happened with some participants in the Soviet Union's program for the development of weapons of mass destruction, while David Hecht made a similar analysis of the role of American nuclear scientists in the US atomic bomb program late in World War II.

A related moral issue in connection with creativity is described by Kevin Hilton. One person's acclaimed and highly respected artistic/aesthetic creativity may inspire another person's antisocial behavior, despite the absence of any negative intention on the

part of the creative individual. An obvious example is the copying of evil deeds depicted in imaginative works. Hilton gives the examples of a murder committed using a technique described in the novel *Shibumi*, and a double murder committed by copying a scene in a Clint Eastwood film. Another example is the 'Werther effect': A wave of suicides inspired by Goethe's book, 'The sorrows of young Werther,' caused the book to be banned in several countries. An artistic creation that is successful in informing, entertaining, even inspiring readers, listeners, or beholders (which seems moral enough), may simultaneously encourage, promote or provide models of behavior which should not be emulated. Perversely, it even seems that in such situations greater creativity may be more likely to promote antisocial behavior: the greater the creativity, the worse the negative effect.

One of the potentially destructive aspects of creativity is that it involves dissatisfaction with what already exists and an inability or unwillingness to accept the status quo. Albert Einstein reported how his recognition that existing theories of electrodynamics were inadequate motivated him to develop the special theory of relativity and then the general theory. Einstein continued to be dissatisfied with his own theory, and worked on it for much of the rest of his life. America's most distinguished inventor, Thomas Alva Edison, was never satisfied with his own inventions, and over the years took out more than 100 patents on the electric light bulb alone. Michael Mumford and Peter Moertl described two case studies of innovation in social systems (management practice and student selection for admission to university), and concluded that both innovations were driven by 'intense dissatisfaction' with the status quo. Thus, seeing that something is wrong with existing knowledge, criticizing this knowledge and seeking to overthrow it are core elements of the creative process. These can be very threatening for people around the creative individual.

Focusing on artistic and aesthetic creativity, Liane Gabora and Nancy Holmes gave examples of its destructive effects on creative people themselves, listing numerous 20th century poets, writers, musicians, and painters who committed suicide. They also reviewed discussions of the question of whether creativity causes psychological disturbance or psychological disturbance leads to creativity. They referred to the 'shadowy swamplands of the creative mind,' and suggested that creativity may lead people to delve into destructive elements of the unconscious in a process of 'deep mining into the darkness,' sometimes bringing to the surface material that less-creative people—wisely—leave undisturbed. They suggest that precisely this process of going where others fear to go may lead to an 'allure of darkness' that makes this side of creativity attractive to some creative individuals as well as to some of the people who admire their work, sometimes with ultimately destructive results. Is such creativity moral, or immoral, even if it yields works of great artistic merit?

Moral Creativity

Despite what has just been said, in a certain sense creativity really is inherently good: As [Jasper \(2010\)](#) pointed out, relevant and effective novelty (creativity) always brings benefits of some kind to someone (otherwise it would not be relevant and effective). The problem is thus not the presence or absence of benefits deriving from creativity, but the distribution of the benefits and the kind of benefit. If the advantages flow in one direction and the disadvantages flow in another, then the creativity is positive for one side, but negative for the other. If the disadvantages to the losing side are of an unjust or undeserved nature or extent (morally indefensible), then the creativity has an immoral aspect. To take a simple example: the invention of the steam engine produced enormous benefits for society, but spelled ruin for highway robbers. However, most people would probably agree that in this case the harm the creativity caused to highwaymen could be ignored (or even welcomed), because such harm was just and deserved.

The Relativity of Benefit

The crucial question is for whom the benefits flow; what David and Arthur Cropley call 'relative' benevolence. [Robert Sternberg \(2010, p. 318\)](#) extended this two-dimensional approach (benefit versus harm) by discussing three dimensions: intra-personal benefit (benefit for one person only or a small in-group), inter-personal benefit (benefit for other people as well as the person generating the effective novelty), and extra-personal benefit (benefit for the context or setting such as a firm or country, humankind or the environment). These three dimensions help to make the difference between moral and immoral creativity clearer. Creativity that provides extra-personal benefits has good prospects of being moral, whereas creativity that involves only intra-personal benefits can easily lead to harm for others. Even though worldwide drug dealing, human trafficking, or terrorist disruption of normal life may generate strikingly effective novelty and bring great benefit to the perpetrators, at the extra-personal level there are many losers, and the creativity involved is clearly immoral.

The idea that moral creativity can be defined in such a straightforward and yet broad and sweeping way as generation of effective novelty that promotes the common good may seem excessively simplistic. However, it is consistent with the views of philosophers who have wrestled with the issues at stake. Immanuel Kant defined creativity as 'the aspiration to create a perfect world for everyone.' He also defined creative genius in terms of producing ideas that are both original and exemplary. By 'exemplary' he was referring to the categorical imperative to fulfil all moral duties. Brian Henning worked out a number of obligations for moral creativity from the writings of Alfred North Whitehead: The obligations include beauty (to bring about the widest possible universe of beauty), love (to maximize the intensity and harmony of oneself and everything within one's sphere of influence), and peace (to avoid destruction). All of these obligations involve a responsibility to avoid doing harm to others and to promote the common good of the larger society.

Recognition of the link between moral creativity and furthering the well-being of other human beings is not new and is not confined to the western world. The Chinese Emperor, Han Wudi, who reigned until 86BCE, was intensely interested in finding

innovative thinkers and giving them high rank in the civil service, and reformed the method of selection of mandarins to achieve this. Writing in the 17th century, both Francis Bacon and René Descartes, two of the founders of modern science, saw creativity as involving the harnessing of the forces of nature for the betterment of the human condition (i.e., for moral purposes). Among Indigenous Australians and the Maori people of New Zealand, First Nations in Canada and Native Americans, creativity implies benefiting other members of the community.

Morality and Intention

The most obvious examples of creativity of questionable morality are to be seen in the generation of novel products that harm people or, as is increasingly emphasized nowadays, the environment. This involves what Keith James called 'negative' creativity. The harm to others can be simply a collateral effect; an employee who devises a novel and highly effective way of avoiding work may expose other people to the stresses of overwork, but this is not the primary intent of the negative creativity. More obviously immoral is creativity which has the deliberate and planned primary intention of harming others, referred to by David Cropley, James Kaufman and Arthur Cropley as involving 'malevolent' creativity. A gray area is to be seen in the field of crime. As Lorraine Gamman and Maziar Raein pointed out, 'resourceful offenders' constitute a group '... whose creativity is rarely acknowledged.' According to these authors, some '... criminal "projects" may exhibit the "wow" factor, and even represent paradigm-breaking creative breakthroughs. For this reason, observers are tempted to admire such projects, even though their intention is anti-social.

Thus, at least two factors contribute to the morality of creativity. The first involves the product or outcome of the effective novelty and especially the question of relative benefit. The second is the intent of the individual, or possibly the organisation, generating it. Without the intention of causing harm, creativity is not malevolent, even when its results are harmful or undesirable. It seems certain that Karl Benz, who designed and built the first four-stroke engine, did not do so with the deliberate intention of polluting the environment or killing people, so that, despite its massive death toll, his engineering creativity was not immoral. On the other hand, the 9/11 terrorists set out to create a novel form of attack on their opponents with the deliberate intention of causing the deaths of many people and the widespread destruction of property.

Introducing the concept of harmful intent expands the morality of creativity from two categories (positive—negative) to four (deliberately good, deliberately bad, unintentionally bad and—difficult to imagine in practice, but theoretically possible—unintentionally good). This categorisation makes it possible to turn attention from the products of creativity alone to the motivation of the person or persons generating the novelty. Runco (1993) referred to the four 'quadrants' and Cropley (2010, p. 367) named the quadrants 'consciously benevolent creativity,' 'failed benevolent creativity,' 'consciously malevolent creativity,' and 'failed malevolent creativity.' Only the latter two are immoral, despite the possible bad outcome of failed benevolence and the possible harmless outcome of failed malevolence.

The Role of Wisdom in Moral Creativity

Kevin Hilton saw a need for 'social wisdom' in creativity. This is based on a 'multi-perspective community approach,' and relates the effects of creativity to its social context. To promote understanding of the relationship of creativity to the social context, Hilton called for emphasis on 'the hard-won insights of the past,' thus incorporating the historical context and the accumulated wisdom of previous generations into the understanding of morality in creativity. Robert Sternberg, too, identified the crucial factor in moral creativity as 'wisdom.' He sees wisdom as involving awareness of the need to balance personal interests and the general good, willingness to do this, and the ability to do so—to find a compromise path that satisfies both sets of interests. The central characteristic of wisdom—as against, for instance, intelligence—is concern for the common good: A wise person tries to contribute to the common good, not to pursue solely his or her own advantage, and moral creativity seeks to generate effective novelty in order to promote the common good.

From an American point of view, the 9/11 attack did not display wisdom, since its intention was not to serve the common good, so that, despite its surprisingness and effectiveness, it was immoral. Nonetheless, it may well have seemed to the attackers—rightly or wrongly—to be advancing the common good of some other ethnic or national group(s), so that even wisdom is relative. In times of war this issue becomes particularly acute. People who generate effectively novel devices with the sole purpose of inflicting damage and death are frequently judged to be acting in a moral way by one side in the conflict, even though it is clear that they understand the 'common' good in a relatively narrow way.

How Do People Become Moral?

Moral creativity can bring great benefit for human beings and their environment, but immoral creativity can bring great harm, as was discussed above. It seems to be a matter of public interest that creative people possess positive moral values and apply them to their own behavior. How does this occur? Evolutionary biologists and socio-biologists believe that morality develops as a result of evolutionary forces. Seeking justice, fostering the well-being of others, showing courage, co-operating with others, and similar behaviors are not the only behaviors of which people are capable. Unfairness, lack of concern about others, avoiding danger, and exaggerated individualism are also possible (and indeed, are not especially uncommon in real life). The widely-accepted morality outlined above is thus not absolute, but relative, and in theory any set of values could be adopted. However, properties such as justice,

concern about the well-being of others, co-operation and courage enhance the survival both of the individuals who display them and also of the collective to which the individuals belong. As a result, such moral values have come to prevail through the process of natural selection. Indeed, according to biologists, simple versions of what humans regard as morality are seen in all species.

In psychological thinking, however, the acquisition of moral values is mainly regarded nowadays as the result of learning from other people. According to the psychoanalytic view, morals are imposed upon the developing child by its parents, and are resident in the super-ego, from where they may cause neurotic symptoms in the individual when they conflict with innate drives that are oriented towards the satisfaction of individual, self-centered urges, possibly at the expense of the collective. However, the most influential modern description of the psychological process of moral development is that of Lawrence Kohlberg. He proposed that children acquire understandings of concepts such as justice, equality and concern about the welfare of others as they move through a series of six developmental stages. At the lowest level, young children define right and wrong in terms of immediate concrete effects on themselves (e.g., an action is bad if you get punished for it—Stage 1, or an action is good if you get something desirable out of it—Stage 2). As children become more cognitively mature, they come to understand that other people have interests that differ from their own, that these may also vary from person to person, and that good and bad reflect an interplay among the array of interests. At the highest level, people understand that morals are higher-order abstract principles that promote smooth functioning of the society at large and are based on reciprocal relationships marked by characteristics such as trust, loyalty, respect, or gratitude; these protect everyone, not just in the short but also in the long term. There is an understanding that morals such as, for instance, respect for life and human welfare transcend particular cultures, societies and eras. Although Kohlberg's stages may no longer be regarded as a literal and exact description of the course of moral development, they offer substantial insights into the course of moral growth and how to foster it (see below).

How Can Moral Creativity Be Fostered?

This section focuses on the contribution of education to the growth of moral creativity. The traditional approach involved teachers explicitly advocating virtues such as honesty, kindness, patience, or strength, for instance through direct communication of their belief in such virtues, by personal example, and by giving students opportunities of practising these virtues and rewarding such expression. This process was frequently supported by separate classes on moral and ethical behavior, such as religious instruction or civics. A common teaching method for doing this was to present a moral dilemma to students and ask them to work out an appropriate moral course of action. Class discussion would then focus on deviations from justice, fairness, or other moral principles.

The goal of the cognitive development approach to moral education, however, is to encourage individuals to develop to higher stages of moral reasoning. According to Jean Piaget, children understand events in their environment in ways dictated by their level of cognitive development. When they encounter new information that is inconsistent with their existing world view, they must adjust their current understanding of how the world operates in order to make sense of this new information (i.e., 'accommodate'), or else ignore the information or distort it so that it can be incorporated into their existing understanding of how things hang together, after all (i.e., 'assimilate'). The process of adjustment is called 'equilibration,' i.e., reaching a new and stable, expanded understanding of the nature of things by accommodating new and previously discrepant information. It is through equilibration that cognitive development occurs. At the heart of this model is the idea of confronting students with information contradicting their present level of cognitive development, in order to make it necessary for them to accommodate and thus reach a higher level.

In order to achieve this, writers such as Piaget argue that educators should provide students with opportunities to discover morals themselves, rather than simply indoctrinating them with norms. Kohlberg argued that moral education also requires more than individual reflection, and should include students functioning within a community. This could be done by emphasizing cooperative decision-making and problem solving, in order to make it possible for them to work out for themselves ethics based on fairness, consideration for others, altruism, loyalty, and the like. The 'infusion' approach emphasizes that, rather than simply being an add-on, education offering such experiences should permeate the entire school experience. It is not a competitor with or an ancillary to the acquisition of academic knowledge and skills, but supports this process: responsibility, respect for others, self-control and diligence foster academic learning. The point is to convey to young people an image of the kind of people the particular culture admires and wants them to emulate. Teachers should speak openly of 'good' and 'bad' and of 'right' and 'wrong.' Words such as 'responsibility,' 'honesty,' 'consideration,' and 'perseverance' should be used in discussing actions and behaviors.

Infusion with moral and ethical issues seems most obviously possible in language arts, social studies, history, and similar areas, but it is also possible in science, sport, technology education, and similar areas of curriculum, where honesty, consideration for others, fairness, ethically-acceptable behavior, and similar values can be discussed. Infusion also involves out-of-class activities, even behavior in the schoolyard, the toilets, the locker room or the lunchroom. Infusion involves the development of a positive moral climate in an entire school. A related approach is service learning, in which children are given classroom chores such as passing out library books or straightening the desks and chairs, at the simplest level, tutoring or mentoring younger children later, and, eventually, performing service activities such as carrying out an internship in a seniors' residence or a day-care center.

Robert Sternberg argued that wise thinking can be developed, and outlined activities students should engage in: These include reading classic works of literature and philosophy (i.e., engaging with 'the hard-won insights of the past,' as Kevin Hilton put it), and participating in class discussions, projects, and essays that encourage discussion of the lessons to be learned from these works and how these lessons can be applied to everyday life. Sternberg also recommended particular emphasis on the development of dialogical and dialectical thinking. Dialogical thinking involves understanding significant problems from multiple points of view and

understanding how others can see things differently. Dialectical thinking involves understanding that ideas pass from the past to the present and from the present to the future. Students need not only to acquire factual knowledge, but also to develop their own values through reflecting upon such knowledge. Instruction should place greater emphasis on critical, creative, and practical thinking that benefits not only the individual doing the thinking but others as well. Students would be encouraged to think about how almost everything they study might be used for better or worse purposes, and to realize that the ends to which knowledge is put do matter. Sternberg and colleagues have constructed a program for teaching American History based on these principles.

Concluding Remarks

Despite the commonly voiced view that creativity is beyond questions of virtue and wickedness, to paraphrase Sternberg, the ends to which creativity is put *do* matter. We need concepts that make it possible to distinguish between the creativity of people who bring great benefits to humankind in both artistic/aesthetic domains (fine art, literature, music, and the like), as well as in technology, business, science, public administration, and similar areas, and the creativity of those whose creativity harms other people. Moral precepts provide guidelines on how to do this. Although morals are, in theory, arbitrary, at their core is a set of values that are shared by a wide variety of cultures over a long period of time. The heart of these is the idea of fostering the well-being of others. Thus, the application of creativity to serve narrow interests at the expense of the wider community is immoral, whereas applying it to enhance the common good is moral.

Morals are acquired, and can be taught. However, rather than being imposed by exhortation or diktat they should be worked out by each individual, and should be based on shared experiences, both of what past generations worked out and recorded in, for instance, great works, as well as on direct interactions with contemporaries, especially in activities that involve contributing to the common good. In this way, people acquire wisdom, and wisdom makes it possible for them to apply creativity in ways that balance private and common interests, and is thus moral. The purpose of placing emphasis on moral issues in creativity is not the self-righteous imposition of a rigid set of pre-specified values on the generation of effective novelty, but encouraging those who generate or use such novelty to examine their own efforts from the moral point of view.

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Motivation

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Introduction

What factors push people to engage in creative activity? Is it caused by ambition and the need to show off or rather driven by the pleasure given by the activity itself? Are people able to behave more creatively when creating alone, or rather when surrounded by important others? Do their beliefs and values regarding creativity determine their interest and effort and, if yes, when and how? Does there come a time when a person's creative purpose and pursuits are foundational to a person's identity, driving their choice to be creative?

One view is that creativity is polimotivational – many different complementary, contrasting, and even conflicting reasons can lead to creative thinking and action. Individuals may feel ambition to be creative or pursue a creative challenge to satisfy some external pressure and find before long that they have lost—or never had—any intrinsic drive, joy, or identity with the creative activity at hand. To be clear, some factors are definitely more prominent than others when it comes to creative activity and outcomes. For instance, children and youth are highly motivated to be creative through play when conditions allow for self-directed, intrinsic curiosity to take root. Adults can be intrinsically motivated by play as well; however, especially in the professional realm, adults can be motivated toward creative achievement by more external factors, such as rewards, praise, or competition. For instance, the phenomenon of televised talent competition shows, such as *America Got's Talent*, *The X Factor*, or *Dancing With The Stars* stokes the creative fire of thousands of amateur performing artists and entertainers through a mix of contrasting intrinsic and external drivers, such as passion and competition. Understanding what motivates people to be creative is complex and requires taking multiple perspectives to understand clearly.

Classical theorizing on motivation in creativity has taken an individualized perspective, mainly positioning the motivation to be creative as the internal workings of the individual. That approach has neglected the role of the sociocultural context in shaping and sustaining the motives and beliefs of the individual engaging in the creative process (Glăveanu, 2011). In response, the field of creativity research has developed multifaceted models to understand the role of a variety of motivational factors in creative development and production. Integrated models include both ability (e.g., dispositions, knowledge, and skills), motivation (e.g., goals, experiential drive, identity, and persistence), and context (e.g., social and cultural factors). Integrated models link the environmental conditions with the person-level creative resources to understand individual differences in creative development and performance (Amabile, 1983). However, past integration of motivational theory has focused on mechanisms within the individual and largely ignored the sociocultural setting in which creative thinking and behaviors occur. This entry explores creativity research, looking for connections between motivational mechanisms and creative outcomes. Creativity research that integrates the sociocognitive perspective is presented and new potential directions in creativity research to bridge sociocultural theories of identity, motivation, and behavior noted. Those models provide new opportunities for research on the affective and motivational dimensions of creative thinking, behaviors, attitudes, and development across the lifespan.

Motivational Mechanisms and Creativity

In creative thinking and behaviors, researchers pursued a number of links between motivational mechanisms and creative development and achievement. Intrinsic interest—motivation to do something for its own sake—was studied for decades demonstrating consistent support for creative behaviors. Extrinsic motives and rewards can also enhance creative performance, depending on the context and type of reward; in some settings, however, they also may be a deterrent (Eisenberger and Aselage, 2008). An individual's self-efficacy, defined as “perceived confidence to creatively perform a given task, in a specific context, at a particular level”

and self-concept delineated as “holistic cognitive and affective judgments of creative ability in and across particular domains” (Karwowski et al., 2019, p. 399), in part, shape an individual’s affect toward a creative task. Those creative self-beliefs suggest that creative behavior can be considered as agentic action (Karwowski and Beghetto, 2018). The study of creative mindsets investigates “beliefs about the nature of creativity itself” (Karwowski et al., 2019, p. 399) integrates implicit theory research about malleability of intelligence and demonstrates a unique role in shaping motives for creative behavior and responsiveness to messaging and modeling in the environment.

In the sociocultural setting of a classroom, other forces are at play in supporting creative development, including the fundamental needs for sense of autonomy, belonging/relatedness, and competency (Anderson et al., 2019). Affective theory from neuroscience (Anderson, 2018) and psychology suggest that mood and embodied emotional states that also shape motives are at play in creative generation. Creative thinking and behavior face pressures to conform to the expectations and norms of others and requires the willingness to take risks in thinking and acting in unconventional ways. Motivational theories grounded in the sociocultural context suggest that individual motives and resulting behaviors and efforts depend largely on the dynamic construction of their identity in each context, especially in relation to a sense of belonging.

Logically, the role that creative thinking and behaviors play in an African-American students’ identity may be very different in an academic school setting with predominantly white peers, white teachers, and white, dominant-culture content than in the community-based dance classes she attends outside of school with an African American instructor and peers. Some scholars argue that social identity and shared appreciation for certain kinds of creative thinking and behavior plays a large role in motivating individuals to approach creative challenges.

Integrating Motivation Theories

Pioneering motivational theories as well as more extraordinary approaches provide different explanations for why people create. For instance, the idea that some people possess a stronger need for achievement than others could certainly explain differences in creative accomplishments. Some have found the allure of romance and sex to boost the creative output of individuals, partially as a result of enhanced affective mood and arousal, suggesting a link between sexual selection and creative production (Griskevicius et al., 2006). Clearly, a range of motivational models build from the premise that an individual’s motives and affect shape their creative process within the sociocultural context in which they think, make, act, and develop. Both the context and the person-level resources brought to that setting play a role in the individual’s pursuit of creative thinking and action in an integrated and, often, reciprocal process. Theories in motivation help to clarify how contextual conditions and the resources of the individual interact to form the motive for creative thinking and behaviors. For instance, identity-based motivation would suggest that when contextual cues activate a creative identity in an individual, they are more likely to behave and think creatively; moreover, they would be more likely to recognize challenges met along the way as normal and signifying importance (Oyserman et al., 2017). Social identity (Haslam et al., 2013) and participatory approaches to creativity urge scholars to look beyond the individual-level mechanisms that shape motivation to be creative; however, previous work in motivation theory at the individual level does provide important insights to shape future directions in research on motivation and creativity.

Self-Determination Theory and Fundamental Needs

Importantly, across age groups, extensive research indicates that intrinsic interest and enjoyment in the challenge of the work is a critical force for continued engagement and risk-taking in creative endeavors (Hennessey and Amabile, 2010). Conversely, extrinsic rewards and incentives may not consistently lead to higher creative output in the educational context (Hennessey, 2015). Yet, some research suggests that, when rewards are relevant to the task or salient to the individual, higher creative performance can result in both educational and professional settings (Eisenberger and Aselage, 2008). Generally, though, extensive research through a self-determination framework indicates that extrinsic rewards of all types—engagement-contingent, completion-contingent, and performance-contingent—undermine intrinsic interest and performance in a variety of creativity-related behaviors across age groups (Deci et al., 1999).

In contrast, positive feedback related to intrinsic interest and free-choice will likely support creative behavior. Across five different cultural contexts, intrinsic motivational factors supported creative performance, whereas, extrinsic reward was less consistently supportive for younger students (Hennessey, 2015). Some individual characteristics also influence the role of extrinsic motivation, including cultural background, gender, and personality, among others. Environmental conditions, instructional choices, types of extrinsic rewards and feedback, as well as individual characteristics shape accessibility, challenge level, and skill attainment within a creative endeavor. Those dimensions are key ingredients to generating *flow* experiences of enjoyment and immersion for the individual, which have been connected to the creative process across domains (Csikszentmihalyi, 1997).

Goal Orientation and Creative Pursuits

An individual’s goal orientation in a creatively demanding task can depend on many factors, such as external reward or social pressure, and that orientation to *mastery* versus *performance* and *approach* versus *avoidance* can dictate how a person feels and produces. A drive toward positive outcomes through a *proactive approach* orientation can promote creativity, support the individual to view

creative challenges as opportunities for self-fulfillment, and help the individual cope with setbacks and persist with resilience. For instance, research with a sample of Taiwanese junior high school students revealed links between mastery goal structure of a classroom and divergent idea production. Mastery goal structures may shape students' intrinsic and self-regulated autonomous motivations in mathematics learning further supporting greater fluency in divergent thinking (Peng et al., 2013).

Social Cognitive Theory and Human Agency in Creativity

Though creative acts take place within a sociocultural context, the individual plays a role in bringing that creative act to life. In this way, creativity can be seen as a choice with common properties to human agency—intentionality, forethought, self-reactiveness, and self-reflectiveness (Bandura, 2006). One primary facet of human agency is the prospective self-efficacy beliefs in one's ability to be successful. For instance, if one doesn't feel confident to improvise missing ingredients in a recipe, the choice to take a creative risk in the kitchen is unlikely, and the possibility for an unexpected innovation will remain closed.

New research has begun to underscore the importance of creative self-efficacy and other creative self-beliefs in shaping creative action. For instance, the link between creative potential and creative activity and achievement was explained, in part, by the level of the individual's self-efficacy (Karwowski and Beghetto, 2018). Logically, the role of creative self-beliefs links to other motivational systems, such as intrinsic interest and the personal value of being creative. For example, the creative self-beliefs of secondary school students in the United Kingdom predicted intrinsic and extrinsic motivation and literacy achievement at similar levels (Putwain et al., 2012).

In addition to self-efficacy, an individual's locus of control and valuing of the task are other aspects of the SCT model of human agency, each with rich theoretical and empirical work and clear implications for creativity. For instance, from a SCT perspective, the social and contextual modes of agency require greater attention in creativity research, especially in the educational context. Personal valuing of creative attitudes, such as risk-taking, and creative thinking and behaviors links to expectancy-value theory, which has been largely ignored in creativity research. However, the costs and risks of being creative are often real and such cost-benefit analysis exists whether or not it occurs consciously. From an expectancy-value perspective (Wigfield, 1994), creative thinking, attitudes, behavior, and accomplishments will have four different components of subjective value: (a) the attainment value as the importance of doing well in the creative endeavor; (b) intrinsic value in the form of pleasure and fulfillment in the activity (similar to SDT framework); (c) utility value or usefulness in the current and future plans and goals of an individual; and (d) cost value, which refers to what an individual needs to give up in their choices for creative thinking and engagement. Though underutilized in research on motivation and creativity, this level of specificity to operationalize value in creative agentic action may be helpful for future research from a sociocognitive perspective.

New Directions for Motivation and Creativity

Though identity and creativity have been studied through a variety of frameworks, there has not been an emphasis on the connection of identity, context, and motivation in creative pursuits. Identity-based motivation theory provides an opportunity to theorize in this interconnected approach. Identity-based motivation bridges multiple motivational models within a situated and sociocultural perspective conceptualizing the self as a moment-to-moment dynamic construction of identity based on the individual's experience within a specific environment. From that perspective, the self is comprised of content (e.g., how creative one might think they are and how likely they are to be creative in a certain task or context) and metacognitive process (e.g., how one feels in creative thinking and action). As such, identity-based motivation provides a "social-psychological theory of human motivation and goal pursuit. It explains when and in which situations people's identities and self-concepts motivate them to take action toward their goals" (Oyserman et al., 2017, p. 140). In this way, identity-based motivation may provide creativity research a lens to learn more about the connection between identity, motives, context, action, and performance.

Three main features of identity-based motivation are important to consider in relation to the study of motivation and creativity in context. First, identity-based motivation assumes that the immediate context is capable of shaping an individual's identity in a process of dynamic construction that shapes action and thought—meaning *identities have value*. Second, individuals are likely to act in ways that are congruent with the constructed, and currently active, identity, preparing them for action—meaning *identities are for action*. Third, if goal pursuits and actions align with that identity, then the experience of difficulty faced in that activity will mean that challenges are normal and expected. When there is incongruence between identity, goals, and the activity, difficulty will be interpreted as diagnostic of the individual—meaning the activity is *not for people like me* (Oyserman et al., 2017).

In creative thinking, attitudes, and behavior, the premise of identity-based motivation aligns to the sociocognitive model of creative behavior as agentic action and extends that model to consider how the dynamic construction of a creative identity will be determined, in part, by the nature of the context. According to an identity-based motivation perspective, how an individual approaches an opportunity or challenge for creative thinking, attitude, and action depends on the congruence between their active identity and the context and activity—*do they know themselves to be creative in that context*. When they meet an obstacle in that creative endeavor, that congruence or incongruence will determine how they interpret success and failure. The identity construction process and resulting congruence will be determined by subtle cues in the environment that may define who is considered creative and what kinds of creative thinking and behaviors are valued or not. Identity-based motivation can respond to recent calls in the educational psychology and creativity fields to integrate the complexity of race, culture, gender, and other dimensions of identity and social

behavior into theory, practice, and research (Glaveanu et al., 2019). Additionally, recent framing of links between identity development and creativity in adolescence provide three pathways to consider—identity exploration as a parallel to divergent thinking; creative self-expression as a process of identity discovery; and creative commitments as a buttress to healthy identity commitments (Barbot and Heuser, 2017). Identity-based motivation may provide an exemplar model to integrate into future research on creativity and motivation.

Fortunately, a growing body of research has demonstrated the effects of identity-based motivation on important motivational and academic outcomes (see Oyserman et al., 2017, for a review) and provides model intervention strategies to test the theory in practice. Results to date suggest that the theory plays out in the reality of young people in an educational context. These studies randomly assigned students to a condition or set of conditions that reflected one or more aspects of identity-based motivation, such as amplifying a contextual cue to activate the construction of a particular identity (Elmore and Oyserman, 2012). Another study manipulated the fit between identity and context (Oyserman et al., 2015) and another altered a contextual cue to be more immediate and relevant in the student's future self (e.g., Nurra and Oyserman, 2018). Advances in identity-based motivation theory provide important pathways for creativity scholars to pursue, regarding the role of identity, context, interpretation of difficulty, and action readiness across different developmental stages and in different contexts. Naturally, this approach to studying motives for creative thinking and action is situated in the sociocultural context from which creativity will arise and be recognized.

Conclusion

Contemporary theorizing in motivation and creativity has shifted a focus toward the interaction of the individual and the context providing new ways to conceptualize why people think, act, and develop creatively at different stages of life. Though more classical motivation theories, such as need for achievement, self-determination theory, and social-cognitive theory, shed light on the issue of why people create, those theories generally focus on the individual, ignoring much of the context surrounding the individual. When the sociocultural context is ignored, what may look like a lack of motivation to create could actually be a protective factor in response to heightened risk or pressure to conform to dominant cultural norms. In this way, research may begin to shift the question from *why do we create* to *when and where do we create and why?*

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Multiple Discovery

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Introduction

If we select a sample of undergraduate students and ask them the following questions: Who invented the telephone? Who invented calculus? Who created the periodic table? and Who invented the telescope? Most of them will be able to answer Alexander Graham Bell, Isaac Newton, Dmitri Mendeleev, and Galileo Galilei respectively. Perhaps this reflects an educational system that prefers one correct answer for one question. However, the broader truth to the questions mentioned above is that all these discoveries (and others) were invented, created, or designed by more than one person. This is a phenomenon known in the scientific discovery literature as *multiple discovery* (Merton, 1961). Although this phenomenon and the controversy surrounding it started in the 17th century, the debate reached a peak in the 20th century among four groups of scientists: historians, sociologists, psychologists, and philosophers. These four groups of scientists offered somewhat different explanations for the multiple discovery phenomenon. While philosophers supported the logic theory, historians and sociologists supported the zeitgeist theory. The psychologists were divided into two groups: one claiming that multiple discovery could be explained by following logic (Simon and Newell, 1971) and the other group claiming that multiple discovery could be explained by the genius theory. Yet, among psychologists a third interpretation emerged when Dean Keith Simonton discussed the role of chance in scientific discovery (Simonton, 1979). Thus, there are at least four competing theories for multiple discovery. In this article the term *multiples* will be used in place of multiple discovery. First, it is necessary to discuss the phenomenon of *multiples* as it resides within the context of creativity, which hopefully will clarify some subsequent issues related to *multiples*. The third section in this article offers examples of *multiples* that originated within three different domains: (a) agriculture, (b) psychology, and (c) chemistry. The fourth section of this article discusses the four competing theories of *multiples* in detail. The fifth section discusses the possibility that all these theories of *multiples* can be valid to some extent. A brief discussion on the future of *multiples* is offered.

Multiples Within the Systems Model of Creativity

One of the major theories in creativity research is the systems theory (Csikszentmihalyi, 1990), which consists of three interactive components: the person, the field, and the domain. The broadest component, the domain, represents the body of knowledge within each discipline such as arts, mathematics, science, and social studies. This body of knowledge includes theories, methods of studying different phenomena, assessments, facts, and indeed problems that need to be tackled by those working within the domain. The fundamental component, the person, represents individuals studying in each domain. After acquiring a high level of expertise within the domain through studying, attending conferences, mentoring, and other means of acquiring knowledge, only a proportion of those individuals will come up with new and useful ideas that might advance the domain. Yet, ideas generated by the person are subjected to scrutiny by the third component of Csikszentmihalyi systems' model, the field. The field refers to the experts or gatekeepers who decide whether an idea, proposition, or product generated by an individual is creative or not. If the field accepts the new idea, then it becomes a part of the domain. Of course, not all individuals working in the domain have the ability to produce original and useful ideas that can take the domain a step further or revolutionize the domain. Beside expertise, the ability to find novel problems characterizes those individuals who raise new questions rather than solving well-defined problems. Indeed, there is a big difference between problem finders and problem solvers.

The systems' model can explain *multiples* in at least two ways. First, as indicated above, each domain consists of pool of ideas or problems in which more than one scientist (person) is trying to solve; hence, it is possible that within any domain, two or more scientists will be working on the *same* problem. Second, domains differ in the number of researchers, or what can be called the domain population. It is, therefore, expected that the larger the domain, the more the possibility that two or more scientists will be working on the same problem compared with other domains consisting of small number of researchers. The link between the systems' model and *multiples* will be discussed with more details in the chance theory of multiples below. After understanding the concept of creativity within the systems' model, it is now appropriate to give some examples of *multiples*.

Examples of Multiples

The objective of this section is to offer some examples of *multiples*. Among famous *multiples* are the steam boat, the theory of natural selection, the invention of electric motors, the telegraph, the law of conservation of energy, the invention of photography, the microscope, the telescope, the discovery of oxygen, and the invention of calculus. In fact, the number of *multiples* cases are abundant. Thus, the plan is to give three examples from three different domains.

The first example is the discovery of the first hormone herbicides. A herbicide is a chemical used to kill unwanted plants. For instance, killing weeds but leaving the corn or soybean crop unharmed. This is an interesting example of *multiples* because four groups of agriculture scientists did discover it and it revolutionized modern agriculture. Interestingly, two groups in the United Kingdom (William Templeman and Philip Nutman) and two groups in the United States (Franklin Jones, and Ezra Kraus & John Mitchell) made this discovery simultaneously. Their research was conducted during the World War II, with all four groups of discoverers unaware of other's works (Troyer, 2001). Due to the difficulty of publishing articles during wartime, none of the four groups of scientists had published their discovery. The discovery of first hormone herbicides was first published by not original discoverers, but by others who came later (Troyer, 2001). What is significant about this discovery is that hormone-like herbicides such as 2, 4-D, 2, 4, and 5-T can selectively kill many weeds at a low cost. In this example, the lack of communication between the four groups of scientists should be noted, because it explains this instance of *multiples*. Consequently, we can expect that the frequency of *multiples* would decrease with the growth of communication. In the 21st Century, the communication among researchers has increase exponentially.

Although the search for *multiples* has been in fields such as Chemistry, Physics, and Biology, this phenomenon is not limited to the hard sciences. The second example concerns a discovery in psychology. The rare, yet interesting case of Accidental Proneness Theory. Two psychologists who were not aware of each other's work proposed this symptom: Karl Marbe from Germany and Eric Farmer from Britain. In 1925, during the World War I, both happen to publish their theory in a local publication. By 1926, Marbe and Farmer published a comprehensive version of their theory of accidental proneness. Accidental proneness proposes that some people are more inclined to be injured than others. Both Marbe and Farmer used statistical probability to prove this phenomenon. Marbe and Farmer found that the probability of having a future accident was greater for those who had had an accident in the past (Burnham, 2008). According to accidental proneness theory, accidental injury and accidental illness are not normally distributed. Regardless whether we agree or disagree with this theory, this case study is an example of a *multiples* in an area other than the hard science. However, Simonton suggests that the occurrences of *multiples* in psychology are rare events compared to large-scale fields such as medicine and psychics (Simonton, 2004).

One of the most famous examples of *multiples* in chemistry is the creation of the periodic table by at least six independent scientists: Stanislao Cannizzaro, John Newlands, William Odling, Gustavus Hinrichs, Julius Meyer, and Dimitri Mendeleev. This case represents multiple discovery rather than simulations discovery, since different scientist discovered it over a period of seven years. Cannizzaro, an Italian chemist, published a three-dimensional periodic system, but his contribution was unknown partly because the publisher of his work did not publish Cannizzaro's full work. What was unpublished was the most critical element of the paper, the diagrams. The second discoverer, Newlands, a British chemist submitted for publication an article presenting a periodic table with 24 elements. However, his contribution was criticized by gatekeepers and thus rejected for publication. In light of systems theory of creativity, this discovery was rejected by the experts and thus failed to enter the domain. The third discoverer, Odling published a more comprehensive table compared with Cannizzaro and Newlands' tables, which consisted of 57 elements. Nonetheless, his contribution was unknown because he was more interested in fundamental science rather than classifying chemical elements. He stopped developing his original work. Hinrichs, another discoverer who was born in Germany made a significant contribution by realizing the periodic law, which paved the way for the periodic table. In fact, Hinrichs grouped the copper, silver and gold elements that were ignored in Mendeleev's earliest periodic table. Hinrichs final version of periodic table included 50 elements, but unfortunately his contribution was unrecognized because his work went unpublished for 25 years. Finally, Mendeleev, who got the lion's share of credit among those six discoverers, developed a more exhaustive periodic table consisting of 63 elements (Scerri, 2015). These three instances of *multiples* in different domains provides a backdrop to the theories of *multiples*.

Theories of Multiples

The Zeitgeist Theory

The concept of zeitgeist captures the notion that ideas come to fruition because they are nurtured by a particular period in history. Ogburn and Thomas (1922) who listed 148 significant cases that were made by two or more discoverers conducted the first empirical investigation supporting this notion. According to this point of view, it is the 'times' or zeitgeist that allowed Galileo, Fabricius,

Scheiner, and Harriott to discover sunspots in 1611; Stokes and Seidel to invent the principle of uniform convergence in 1847; and Darwin and Wallace to posit the theory of natural selection in 1858 (Ogburn and Thomas, 1922). These individuals made these discoveries simultaneously and from different locations. They were not aware of each other's work. For example, the discovery of sunspots was made in four different countries (that is, Italy, Germany, Holland, and England) in the same year. It seems that sunspots and other discoveries were made because the technical and cultural times were ripe for them (Merton, 1961).

The zeitgeist interpretation of *multiples* was based on five assumptions: (a) the incremental accumulation of knowledge, (b) the social interaction between scientists, (c) the systematic procedures of inquiry, (d) the idea that inventions are birth of time, and (e) that all scientific discoveries are in principle *multiples*. Collaborative discovery is the norm, and individual insight is the exception. It is singletons that need to be explained (Merton, 1961). However, other groups of scientists criticized sociologists over their interpretation of *multiples*. Is the claim that scientific discoveries are in principle multiples a valid claim? As mentioned earlier, the most comprehensive list of *multiples* was generated by Simonton (1979) with 579 cases. How about the thousands of discoveries that were made by a lone originator? One data source to consider is the US Patent and Trademark Office (USPTO). According to one report published by the USPTO, in the period 1975–2015 the lowest number of inventions occurred in 1983 when 10,548 inventions were filed for patents. These numbers show that the sociologists' claim that multiple scientific authors are the norm is not a valid one. Sociologists of science seem to underestimate the role of individual differences in scientific discoveries.

Many of the intellectuals who were involved in *multiples* demonstrated exceptional abilities. When Isaac Newton was 18 he entered one of the most prestigious schools in Europe, Cambridge University. In his 20s he delineated the foundations for theories of math and physics that eventually revolutionized the world (Hart, 1992). Newton's exceptionality was witnessed by his antagonist, Leibniz, who wrote 'Taking mathematics from the beginning of the world to the time when Newton lived, what he has done is much the better part' (as cited in Hart, 1992, p. 14). Newton and many other scientists were involved in more than one multiple discovery. This might be considered evidence that an individual has to be exceptional to originate a new discovery, multiple or lone.

However, some argued that the lone inventor is a myth, this might not be the case. Francis Bacon and Alan Turing are two examples that fit the profile of 'lone wolf.' Robert Merton (1961) devoted a great deal of his 1961 article talking about Bacon's genius and exceptionality:

No economist, Bacon could in 1615 originate the concept of balance of trade. No great admirer of mathematics but cognizant of the value of quantification, he could write as he did generations before the extraordinary London haberdasher John Graunt, Sir William Petty, and Gregory King could among them fashion the new political arithmetic and so initiate the serious study of demography, urban sociology, and epidemiology. (p. 470)

Furthermore, Merton argued that Bacon legitimized the social sciences at least one and a half century before Auguste Comte, the father of sociology. Similar in achievement, Alan Turing 'sketched the essentials of digital computers about 10 years before these were actually in existence' (Mackworth, 1965, p. 52). Thus, it seems that the zeitgeist's interpretation of *multiples* is incomplete, because Bacon and Turing seem to tower above their 'time.'

The Genius Theory

Genius is somehow a difficult term to define and has often been used in a misleading manner (Simonton, 2004). One of the difficulties stems from the stereotype that links genius with madness, or from perceiving genius as source of inspiration from gods. Although the link between genius and some kinds of mental illnesses is still controversial, the latter perception of genius has been rejected with the establishment of scientific methods in the 19th and 20th centuries (e.g., Galton, Freud, and Terman). It is important to define the construct genius before discussing the genius theory of *multiples*. Genius is not a dichotomous concept in which people are classified into two categories, those who are genius and others who are not. Rather, genius can be put on a scale, or as Simonton (2004) asserted: 'Variation is a matter of degree rather than kind' (p. 18). Therefore, it is not acceptable to say that Newton was a genius where Leibniz was not.

The genius theory, unlike the zeitgeist, accounts for individual differences between scientists. According to this point of view: not everyone can significantly contribute to the advancement of science, and *multiples* are neither the result of accumulated knowledge nor the result of using logic to a high degree. Indeed, logic is important in any creative problem-solving effort; however, logic is insufficient to generate new and unusual ideas. This led some proponents of the genius theory to claim that great scientists have the capability to dispense with logic (Simonton, 2004). But how can genius can be operationally defined? According to Albert (1975) a genius is 'anyone who, regardless of other characteristics he may possess or have attributed to him, produces, over a long period of time, a large body of work that has a significant influence on many persons for many years' (p. 144). A key point in Albert's definition is that a person of genius has the ability to be productive and influential over a long period. Thus, one way to assess genius is to examine productivity in terms of publications. Two important issues related to publication provide a way to assess individual differences among scientist. First is the number of publications scientists produce in their careers. If the all publications are considered equal, the number of publications provide a way to assess scientific achievement. However, it is the quality of research that makes a difference. For instance, Einstein published more than 300 papers through his career, yet only five of his top publications are responsible for 35.5% of citations he received. This is a pattern that Simonton (2004) called the equal-odds rule. The equal-odds rule asserts 'scientists who publish the most highly cited works also publish the most poorly cited works'

(p. 22). Overall, according to the genius perspective some scientists are prolific, consequently, they should be involved in more *multiples*. The genius theory supports the proposition that it is individual differences rather than the spirit of time that accounts for unique discoveries. Yet, how do great scientists come up with original ideas and products? In other words, what distinguishes a man of genius from others? Perhaps the chance theory can help answer this question.

The Chance Theory

The term chance has different meanings. On one hand, chance is defined as ‘the occurrence of events in the absence of any obvious intention or cause’ (Oxford Dictionary of English, 2010). Related to *multiples* are accidental discoveries, that is, when someone was looking for something and then found something else. For example, Roberts (1989) listed 36 accidental discoveries such as the DNA, Penicillin, X-rays, and Columbus’ discovery of the ‘new world.’ On the other hand, chance is defined in terms of probability, finding a new idea through a combinatorial process. A combinatorial process, as it relates to discoveries, can be defined as any mechanism or procedure by which two or more concepts are put together to form a novel combination. Typically, this process entails a search through a range of combinatorial possibilities. Examples of combinatorial models in creativity include Mednick’s associative theory and Campbell’s blind variation and selective retention theory (Runco, 2014). Simonton (2009) discussed in detail how *multiples* could be a result of a combinatorial process through six assumptions.

First, individuals build their knowledge of a particular subject from different sources such as formal education, books, conferences, media, and other sources of knowledge. The subject knowledge that an individual acquires represents a sample of ideas from the larger subject domain (that is, mathematics, physics, psychology, etc.). For individuals working within the same domain, some of the information, facts, and theories will be recognizable and shared. However, not all individuals within a subject domain will share the same level of knowledge. It is expected that there will be differences due to different texts, different instructors, different kinds of training, and so forth.

Second, it is supposed that intellectual and dispositional traits will be randomly distributed regardless whether the size of the domain is large such as mathematics or small such as special education. The third assumption asserts that domains vary in their size. While large fields have many researchers who are actively engaged in solving problems or identifying research questions, other fields may have fewer researchers. Fourth, those active members within each field are subject to quasi-random combinatorial process, that is, they engage in various type of interactions that provide additional knowledge acquisition. Fifth, ideas generated through combinatorial process vary in terms of quality with high quality ideas being rare compared with ordinary ideas. Finally, these ideas generated through combinatorial process are translated into a product via publications, which must be communicated to the field (i.e., expert scientists). As indicated earlier in the systems model of creativity, once new ideas are accepted by the field, they become a part of the domain. The influence a particular academic idea has depends on many factors such as publication type (e.g., books, peer-review articles, magazines, theses, or dissertations) or journal status (major or minor). To summarize, according to the chance interpretation of *multiples*, the occurrence of simulations discoveries can be attributed to quasi-random combinatory processes. This perspective is far from the logic theory of scientific discoveries to which I will now turn.

The Logic Theory

Contrary to the genius perspective, the logic theory of *multiples* asserts that a scientific discovery can be conceived as a logical step-by-step process. In fact, Herbert Simon through his experiments with computer programs provided evidence that discoveries can be predicted by using logic. Among the different programs he and his colleagues developed, BACON seems to be the most famous one. Successfully, BACON rediscovered a number of discoveries such as Snell’s law of refraction, Black’s specific heat law, and Kepler’s law of planetary motion (Bradshaw and Simon, 1981).

Moreover, the logic theory treats *multiples* as kind of problem solving. Like zeitgeist theory, the logic perspective does not account for individual differences in scientific discoveries. According to the logic interpretation of *multiples*, anyone can make discoveries, if he or she employs a step-by-step method that is based on logic. This view of scientific discoveries received criticism. First, the logic interpretation of scientific discovery ignores the role insight plays in scientific discoveries. There is evidence in the creativity literature showing that insight or the aha moment, or illumination as Graham Wallace named it, is part of creative problem solving. Second and more importantly, computer problem solving deals only with well-defined problems. Real life problems are not always well defined. In other words, computer programs can solve problems, but they cannot find problems. Indeed, logic and reasoning are important elements of any creative problem-solving effort. Most models of the creative process include elements related to logic and convergent thinking; however, logic is not sufficient for creative behavior. Therefore, most scholars in creativity field reject the idea that creativity is nothing but problem solving.

Among the Four Interpretations Who Is Right? and Who Is Not?

The past century witnessed a heated debate between four groups of researchers, each trying to demonstrate that their interpretation of *multiples* is more accurate and valid than the other. In fact, none of these four interpretations can fully explain the occurrence of *multiples*, although the chance theory seems to be more precise and coherent compared to the three other perspectives - zeitgeist, logic, or genius. Therefore, instead of adopting one interpretation and thus, asserting that other explanations of *multiples* are invalid,

this article concurs that all four perspectives can be integrated (Simonton, 2004). By using the concept of creativity that embodies the times, individual inspiration, logic, and chance. For most definitions of creativity, the idea or a product must meet two simple criteria, originality and appropriateness. This can be applied to scientific discoveries. First, no one can ignore the role of logic in scientific discoveries. Both divergent and convergent thinking are important for creativity and creative thinking. Yet, logic is important but insufficient to explain or to predict scientific discoveries. Furthermore, creativity is not synonymous with problem solving, especially the kind of problem-solving Simon implies that only requires using logic. Second, it is inappropriate to deny the intellectual and dispositional abilities of discoverers who were involved in *multiples* such as Newton, Darwin, Galileo, Mendeleev, and others. In other words, they were not ordinary individuals as their bibliographies showed.

According to Hart's ranking of the most influential persons in history, Newton rank was 2, Galileo was 12, Darwin was 16, Edison was 35, Graham Bell was 42, and Mendel was 58. Third, with very few exceptions such as Bacon and Turing, the advancement of science is predominately based on accumulated knowledge. This is consistent with one of Simonton's assumption that each individual in any domain can acquire a sample of the domain's knowledge. This sample of knowledge then helps the discoverer combine two or more ideas in order to discover something new and valuable. If we combine the lists of *multiples* generated by Ogburn and Thomas, Merton and Barber, and Simonton, the total cases of *multiples* will be 911 cases, against thousands of singleton discoveries. Thus, the claim of sociologists that singletons are an anomaly that need to be further studied is an invalid one. Finally, the chance interpretation is first among equals because it can account for the mental processes that can lead to creative discoveries and it does not deny the role of accumulated knowledge. Furthermore, the chance perspective reported four kinds of evidence, which shows that combinatorial models can explain *multiples*. First is the distribution of multiple grades. Multiple grades refer to the number of discoverers involved in any case of *multiples*. If the zeitgeist interpretation of *multiples* is valid, then one expects that more individuals will be involved in any case of *multiples*. That is, the frequency of octuplets (8) will be higher than septuplets (7), and the frequency of septuplets will be higher than sextuplets (6), and so on. However, examining the list of Ogburn and Thomas revealed that 89 of the cases were doublet, 36 were triplets, 9 were quadruplets (4), 7 were quintuplets (5), 2 were sextuplets (6), 3 were septuplets, and 2 were octuplets. In other words, the majority (60%) of these discoveries were made by two discoverers.

The same observation was made by Simonton (1979) where 449 (77.5%) out of 579 cases were doublets. Moreover, a new method for identifying *multiples* in scientific publication was proposed by Bikard (2012) who used co-citation proximity. The method is straightforward: if two or more publications were published within one year containing same ideas, this can be an evidence of *multiples* or as Bikard (2012) called it, paper twins. Paper twins were detected using an algorithm that matches papers based on their date, authors, and citation patterns. According to Bikard (2012, p.13), 'paper twins are all pairs of research articles having no author in common, written no more than one calendar year apart, being frequently cited by the same papers and being consistently cited adjacent to each other (in the same parenthesis).' Out of thousands of publications from 1970 to 2009, only 720 papers were identified as paper twins. Not surprisingly, the majority of the 720 paper twins were doublet (70.1%), which is consistent with the multiple grade distribution Simonton (2004) suggested. The second is the temporal separation of *multiples*. Inventions, according to the chance theory indicates that the frequency of *multiples* will be higher in discoveries that happen in the same year than *multiples* that takes years between the first and last discoveries.

For the purpose of this article, Ogburn and Thomas (1922) list was scrutinized for the time lag between discoveries. The method was as follows: for doublet discoveries, the time lag between the first and the last discoveries was calculated. For triplets and above, the time lag was calculated between the first and the last discovery. The result shows that 84 (56.7%) of discoveries were made within four years; a finding supporting the chance theory. Third is the degree of multiple identity. That is, to what extent are discoveries made by two or more discoverers identical.

Discoveries that are fully identical are very rare, if they exist at all. For example, although the Italian physicist Antonino Lo Surdo and the German physicist Johannes Stark simultaneously discovered the discovery of the influence of a magnetic field on spectral lines (Stark effect), those two physicists came from different contexts: classical theory and quantum theory respectively. Finally, the chance theory of *multiples* asserts that individuals involved in one discovery will be highly likely to involve in other *multiples*. Among the 148 cases of *multiples* Ogburn and Thomas (1922) listed, Galileo was involved in seven *multiples*, Newton involved in five *multiples*, Gauss involved in four *multiples*, Laplace involved in four *multiples*, Bradley, Delambre, and Darwin were all involved in two *multiples*.

The Future of Multiples

The main question to be answered here is: will the phenomenon of *multiples* continue to appear in the future? More specifically, will we witness more or less cases of *multiples* in the next 100 years? Perhaps a safe answer will be: it depends. First, if the lack of communication between scientists in the last centuries can explain a proportion of *multiples*, then we expect this phenomenon will decrease with the advancement of communication technology. Scientists from all around the globe can find out whether their ideas were discovered or filed for patent by other scientists. This can be done by searching research databases and patent offices, looking at scientists' websites, or simply by searching Google. Moreover, researchers now can communicate their projects before submitting them to peer review journals through different means such as conferences, websites, ResearchGate, and other means of communications. Second, if the logic interpretation of *multiples* is correct, then the phenomenon of *multiples* will disappear with the unprecedented advancement in the artificial intelligence technologies. That is, computers will discover and solve problems humans will take on a servicer role. Adopting the sociologists of science interpretation of *multiples*, *multiples* will continue to appear since each

discovery depends on the incremental accumulation of knowledge, which is ever increasing. Finally, according to the chance theory of *multiples*, the frequency of *multiple* cases will depend on a number of factors such as the size of the domain. The frequency of *multiples* will be greater in fields where there are many researchers compared to fields of study that have few researchers. It might be interesting to examine the correlation between the size of domains (i.e., individuals working in a particular domain) and the frequency of *multiples*.

To conclude, the chance theory seems to be more comprehensive and convincing than the other three interpretations of *multiples*; since it considers the role of knowledge in discoveries, the individual differences between scientists in terms of abilities and dispositions, and the mental processes required to generate new ideas that lead to creative discoveries. The systems theory, which consists of three interactive components (the person, the field, and the domain), provides an encompassing starting point for the investigation into the origins and nature of scientific discoveries.

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Music

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Glossary

Consonance: When two or more musical tones sound pleasant and stable, due to simple mathematical relations among their respective pitches (as in the notes C and G).

Counterpoint: When different melodic lines in a musical composition proceed simultaneously yet are independent in rhythm and contour. Counterpoint may also refer to compositional 'rules' that guide how composers are supposed to weave together different melodic lines.

Dissonance: When two or more musical tones sound unpleasant and unstable, due to more complex mathematical relations among their respective pitches (as in the notes C and F-sharp).

Dynamics: The relative loudness versus softness of musical notes.

Form: The large-scale patterns by which musical compositions are organized. For instance, symphonies involve much more complex and varied forms than songs.

Harmony: The aspect of music involving combinations of notes, usually into chords (like a major chord consisting of the notes, C, E, and G, or a minor chord consisting of the notes C, E-flat, and G). Harmony may refer to listeners' perception of chords in a piece of music, or to compositional 'rules' for combining notes and transitioning from one chord to another.

Instrumentation: How the notes of a musical composition are allocated to different musical instruments in an ensemble.

Rhythm: The timing of successive notes in a musical composition, in terms of short versus long note (and rest) durations, as well as how those notes map onto an underlying pulse or meter for the composition.

Melody: The sequence of pitches in a piece of music, which are perceived as a unified entity.

Pitch: How high or low a particular note in a musical composition is, given by the mathematical frequency of sound waves associated with that pitch.

Tempo: How slow or fast the basic pulse or beat of a musical composition is.

Timbre: The 'tone color' of a musical sound, which is typically associated with differences in the instruments producing the sound. A clarinet and a violin may play the exact same note, but the different identifiable 'sound' of each instrument reflects its unique timbre.

Introduction

Music is a culturally ubiquitous outlet of human creative expression. Musicality has been identified as a fundamental domain of the mind (Feist, 2004) and figures prominently in debates about the evolutionary origins of modern humans (Justus and Hutsler, 2005). *Homo sapiens* has probably engaged in music for our entire existence as a species, with archaeological evidence for musical instruments dating back to at least 42,000 years ago. In contemporary society, the annual worldwide revenue of the music industry is measured in the billions of dollars, and some surveys suggest that the average person spends some 40% of their waking lives listening to music. From medical and humanistic perspectives, music's ability to entertain, inspire, and heal is well documented.

Creativity is a pervasive aspect of human musicality. Many standard concepts in the mainstream creativity literature straightforwardly apply to music. These include the so-called six P's of creativity (process, product, person, place, persuasion, and potential), theoretical accounts including developmental, cognitive, and systems views, and levels of creative achievement

(see Kozbelt et al., 2010). The latter range from so-called mini-c to Big-C creativity (Kaufman and Beghetto, 2009) and represent the difference between someone privately humming a new tune versus enduring cultural monuments like Beethoven's nine symphonies.

Musical creativity has a constellation of unique qualities that sets it apart from creativity in many other domains. Music itself is evanescent, quickly passing out of personal and cultural memory unless notated or recorded. To the extent that music is an evolutionarily rooted aspect of our human nature, it differs starkly from completely invented artificial domains like chess. Individual differences in musical talent are very prominent, yet acquiring musical expertise takes years of intensive effort (Ericsson, Krampe, and Tesch-Römer, 1993). In practice, musical creativity often departs from the stereotype of a solitary person writing a tangible, definitive work; collaborations and distributed cognition, especially involving performance, are much more common. Creativity may reveal itself in musical composition, improvisation, expressive performance, and even listening. The striking pluralism of musical practices in the contemporary world has led some to question the appropriateness of the singular term 'creativity' in music, suggesting as alternatives 'musical creativities' or 'musical invention.'

The goal of this article is to explore the creative domain of music from the perspective of contemporary creativity research. Musical creativity is first explored from domain-general and domain-specific perspectives, which inform receptive versus productive or performative aspects of musical creativity, respectively. Next follows a discussion of the creative process in music, which has been illuminated by a variety of methodologies. Last comes a discussion of socio-cultural aspects of music and the complex dynamic resulting from common regularities in musical styles and systems, versus the drive for musical innovation. Throughout, the most prototypical creative practices – composition, and to a lesser extent, improvisation – are emphasized, though many of the principles would apply to other musical activities as well.

The Domain of Music

What is the scope for discussing creativity in the domain of music? Many definitions of music have been offered. One representative entry is "the capacity to produce, perceive, and appreciate rhythmic and melodic sounds that evoke an emotional response in oneself and others" (Feist, 2004, p. 61). Most definitions emphasize the production and perception of patterns rooted in basic acoustic parameters like pitch, dynamics, tempo, timbre, rhythm, and so on. Such parameters can be organized into a nearly infinite number of ways, and musical creators' (and interpreters') fecundity in conceptualizing and elaborating musical ideas raises the issue of how best to demarcate the 'domain' of music as a circumscribed area of study.

Domain-generality Versus Domain-specificity in Musical Creativity

The dilemma of how to characterize a domain of creativity is neither new nor unique to music. Indeed, a venerable debate concerns whether creativity is better regarded as more domain-general or more domain-specific. Domain-generalists argue that creativity largely results from all-purpose cognitive mechanisms, including divergent thinking, flatter associative hierarchies, regression into primary process cognition, tolerance for ambiguity, ideational abilities, and creative potential. Evidence for domain-generality typically involves collecting psychometric or personality data and self-report inventories (Baer, 2010) and assessing their predictive validity for real-world creative achievement (Plucker, 1999). On a domain-general account, musical creativity would emerge out of the confluence of such cognitive mechanisms, channeled – for some reason – into musical activities.

In contrast, the domain-specific view argues that general psychological mechanisms are inadequate to explain creative accomplishment; instead, non-transferable knowledge and skills within some domain are required. World-class achievement in complex domains invariably demands enormous effort (Weisberg, 2006). The effects of expertise acquisition are profound. Accomplished music performers differ significantly from non-musicians in neurological, cognitive, physiological, and perceptual-motor terms (Lehmann and Gruber, 2006). Even the greatest composers are not immune, as they typically require at least a decade of intensive study before producing original masterworks (Simonton, 1991).

Additional evidence supporting domain specificity comes from special populations. These include persons with congenital amusia, who are largely unable to process musical information, despite otherwise normal mental functioning, persons with Williams syndrome, where musical abilities are enhanced despite general cognitive impairments, and cases of exceptional musical prodigies, whose talent often emerges earlier than in any other domain.

Without pretending to resolve the generality-specificity debate, a domain-specific stance may be regarded as more useful for studying *productive* and *performative* aspects of musical creativity, while a domain-general stance may be more useful for music's *receptive* aspects (Kozbelt, 2017). Given the traditionally greater emphasis on composition (and improvisation) as the clearest manifestations of musical creativity, much of the ensuing discussion will have a domain-specific orientation, since expert knowledge is essential for effective composition or improvisation. However, the interaction between creators and audiences is critical for understanding socio-cultural dimensions of musical creativity, including how musical styles change over time. These themes become increasingly prominent as ambitious creators' rampant pursuit of novelty may outstrip audiences' capacity to appreciate their productions – a theme taken up near the end of the article.

Music and the Creative Process

While productive, performative, and receptive aspects of music experience can all be considered – at least to some extent – creative, composition is probably the most prototypical focus for studying creativity in music. What are the psychological processes by which music is created or composed? The creative process has long been a staple of research, via multiple methodologies; in music, these have collectively drawn a rich picture of the composer at work. Sloboda (1985) delineated three approaches to gaining psychological insight into music composition: examining written manuscripts and sketches, first-person comments about the composing process, and observation during a session of composition. Archival studies of composers' outputs have additionally informed many issues in musical creativity. More recently, neuroscience studies have likewise illuminated the nature of musical creativity. Each is discussed below, in turn.

Sketches, First-Person Accounts, and Observational Studies of Musical Creativity

Musicologists have long examined composers' sketches and notebooks as a way of understanding their methods and goals. While useful for establishing the complexity of the creative process, understanding sketches – even at the level of deciphering individual notes – demands enormous domain-specific and contextual knowledge, and conclusions remain open to interpretation, since questions about the representativeness, completeness, and chronological sequence of the paper trail can rarely be fully resolved.

Besides sketches and scores, many composers have also left provocative descriptive accounts of their own creative processes. However interesting, such anecdotes suffer from clear methodological limitations, most notably questionable representativeness and veracity, and can be cherry-picked to support virtually any theoretical position (Kozbelt, 2007). Such limitations can sometimes be overcome, but testable hypotheses are often better served by other methods.

Along such qualitative methodological lines, some researchers have investigated the nature of composers' creative processes by more systematic interview and/or observational methods. Sometimes this approach is supplemented with concurrent verbal reporting of their creative process, or analyses of sketches and works-in-progress (McAdams, 2004), to better understand the music composition process.

The fruits of such research have been some sophisticated theories about the psychological mechanisms facilitating musical creativity. Such studies have introduced a host of useful concepts in understanding the creative process in music. A menu of such concepts would include things like the interplay between divergent and convergent thinking, concurrent streams of thought, spreading activation and dissociation, chunking of processes and strategies at both micro and macro levels, a generative process of problem proliferation and successive solution implementation, synoptic planning versus heuristic ideation, generating rules in the course of music writing, cycle development and concern of coherence, and creative borrowing. Basic mechanisms and processes like these play out in several regimes of creative thought. For instance, echoing some more general theories of creativity, Bashwiner (2018) characterized the composition process as structured into three main stages: a generative stage characterized by the effortless flow of ideas, a transformative stage characterized by craftsmanship and elaboration, and an evaluative stage characterized by a composer's hedonic reaction to the products of the first two stages.

In sum, research has yielded many candidate concepts and cognitive processes that are potentially useful for understanding of the nature of the creative process in music. These varied approaches share a view of music as a form of ill-defined problem solving, in which there is no single 'correct' answer or 'best' solution. To achieve a good-enough solution, composers must make many decisions, organizing and structuring their ideas and behavior to transform nascent ideas into a performable product. Composers' means of structuring their creative problem-solving behavior can be regarded as schemas that reflect their domain-specific knowledge. In line with expertise accounts of creativity (Weisberg, 2006), the composition process itself is often regarded as highly rational (Kozbelt, 2008a), which has strong implications for issues like the extent to which creators could learn to control the creative process and become more creative with experience – questions that have been informed by archival studies of great composers.

Archival Studies of Musical Creativity

Archival studies of classical composers use their outputs and pragmatic assessments of the quality of that output (like recording counts or citations in music history books) to test hypotheses on how, for instance, output changes with age (Simonton, 1997). Psychologists have developed two major perspectives on lifespan creativity: the expertise acquisition view (Weisberg, 2006) and the blind variation and selective retention (BVSR) view (Simonton, 1997, 2011). The two theories make different assumptions and predictions about how creativity unfolds throughout creators' lives. The expertise view emphasizes domain-specific knowledge and logical problem-solving processes and is thus optimistic about creators having some control over their creativity and improving with experience. In contrast, the BVSR perspective emphasizes serendipity and a quantity-drives-quality dynamic, and it has traditionally been more pessimistic about the possibilities of creative control and agewise improvement.

The most direct evidence bearing on these two views comes from empirical studies in which aspects of creators' outputs are quantified. One operationalization is career landmarks: the ages at which individual composers began studying music, composing, wrote their earliest acknowledged masterwork, greatest work, and final masterwork, and stopped composing altogether. Some results on career landmarks support the expertise acquisition perspective, particularly the so-called 'ten-year rule' (Kozbelt, 2008a) mentioned earlier, but others do not. For instance, the very greatest composers began studying and writing music – and masterpieces – earlier, and they wrote their last masterpiece later than their less eminent counterparts (Simonton, 1991). Some similar trends apply to

'one-hit wonder' composers (those whose reputations are based on one outstanding work), versus those who produced multiple great works (Kozbelt, 2008b). Such findings suggest the acquisition of expertise and its translation into creative productivity can be strongly modulated by individual differences in creative potential or talent.

Many findings on career landmarks can be understood via the BVSR account (Simonton, 1997, 2011). This theory takes individual differences in creative potential as a starting point and models typical age-wise output in a way consistent with observed results: productivity starts low, rapidly climbs, peaks around age 40, and gradually declines. Intriguingly, the classic BVSR view (Simonton, 1997) explicitly posited a general inability of creators to control the creative process or systematically improve with age. However, subsequent research has revised this view somewhat. For instance, extensive studies of thousands of works by dozens of great composers (Kozbelt, 2008a, 2011) showed significant long-term improvements in several indices of creativity over the course of composers' careers, inconsistent with the classic BVSR model. In these studies, substantial individual differences in trajectories were also notable. Specifically, composers who wrote their best work later in their careers showed stronger age-wise improvements in creativity and weaker quantity-drives-quality dynamics than did early-peaking composers (see Longevity).

The pervasiveness of such individual differences suggests that any sort of one-size-fits-all view of creativity may be misguided. An alternative is to prioritize inter-creator variability, which may be organized into typological categories. One prominent example is Galenson's (2006) framework of 'finders' and 'seekers.' Kozbelt (2012) applied Galenson's typology to music, coupling quantitative findings on variability in composers' career trajectories with qualitative accounts of their compositional concerns and processes. In brief, 'seekers,' who show longitudinal improvement and late career peaks, work in traditional forms highlighting craftsmanship and the development of musical ideas, incrementally and deliberately seek longitudinal improvement within the context of tradition, and distrust preconceived theories of composition. In contrast, 'finders,' who often produce their best-known work early in their careers, prioritize novel ideas, pioneer new musical forms, can articulate their compositional goals via clear-cut theoretical criteria, and show great certainty while creating and confidence in their self-evaluations. Thus, there appear to be many pathways to greatness in music, with variability at one level of analysis (like the creative process) predicting outcomes at a very different level (like career trajectories).

A final aspect of archival research relevant to musical creativity concerns composers' ultimate reputations, operationalized by differential space allotment in music history books. Murray (2003) has amply demonstrated high concordance among varied sources in classical music (and other domains) and has invariably found a strongly positively skewed distribution of achievement, with a few supremely eminent figures significantly outdistancing their nearest competitors and the great mass of contributors at the bottom end of the distribution. Such findings raise the question of how social judgments of the relative importance of different creators and their contributions are formed – a theme taken up below.

Neuroscience Studies of Musical Creativity

In the last several decades, advances in imaging technology have led to a revolution in our understanding of the brain – even on issues as complex as musical creativity (see Neuroscience fMRI). What do such studies tell us? Bashwiner (2018) surveyed some twenty or so neuroscience studies in which participants engaged in musical composition or musical improvisation. While extant research involves a diverse array of neuroimaging methods, tasks, participants, musical styles, and degrees of ecological validity, several overarching consistencies are evident. These include: the frequent implication of motor control regions, especially those used for motor planning and sequencing like the premotor cortex and supplemental motor area; the sometime involvement of non-primary auditory regions; inconsistent involvement of regions of the default mode network, which is associated with internally directed focus and mind-wandering (see Neuroscience Default Network); inconsistent involvement of dorsolateral prefrontal cortex, an area implicated in higher-order cognitive faculties like executive function and cognitive control; and relatively consistent involvement of limbic and paralimbic structures, which are typically involved in emotion processing.

While neuroscience research on musical creativity remains in its infancy, these tentative patterns suggest some routes of future exploration. Deeper insights connecting these brain-based findings with broader questions about the nature of composition and improvisation are likely to arise through a multi-pronged approach. Combining physiological responses, like skin conductance, with better laboratory-based metrics of creativity across a range of musical skill levels and tasks, would likely be a useful direction. Bashwiner (2018) has also contributed theoretical ideas linking composers' reports of their composition process to neuropsychological models of dreaming and so-called bizarre cognition.

Socio-cultural Aspects of Musical Creativity

Psychological studies of the creative process – whether observational, archival, or neuroscientific – are sometimes critiqued on the grounds that they over-emphasize the role of the individual creator, at the expense of communal and collaborative aspects of music, which are extremely common. These include purely musical group efforts like the Lennon-McCartney songwriting partnership, the interdisciplinary interaction of composers with creators in allied domains like film or dance or advertising, improvisation in jazz ensembles, the use of music in group ceremonies, and so on. Along these lines, even some recent neuroscience accounts emphasize music's ability to foster an interpersonal sense of being together in time that is rooted in neural processes of imitation, intention, action, and emotion. Some evolutionary accounts likewise highlight music's ability to promote and reinforce social bonds.

In recent years researchers have paid increasing attention to these issues that transcend individual creators. Fully understanding the nature of creativity in music requires moving beyond domain-specific psychological characterizations of acts of musical

creativity and moving toward the social reception of creative products. This complex, multi-disciplinary topic is replete with unanswered questions and can only be touched on here (see Systems).

The social dynamics of musical creation and appreciation have been much debated by scholars interested in socio-cultural issues. These include how aesthetic choices may reinforce class distinctions, how the social context and situated cultural practice of creative music-making operates, how the plurality of contemporary approaches to music-making works, and how collaborative aspects of musical creativity function. Among these matters, improvisation may be the most underserved specific issue. Oddly, improvisation is simultaneously the most widely practiced musical activity and the least acknowledged and understood – a remark that has long been true, despite growing scholarly interest in the nature of creative collaboration.

Future Directions and Implications

The study of musical creativity is a rich and vibrant scientific enterprise. As this article shows, considerable progress has been made in conceptualizing key issues and in devising theoretical and empirical approaches to understanding them. Much current research benefits from a convergence of multiple methodologies. Future research should continue to pool the many methods now available, coupled with sophisticated computer-based tools to analyze large corpuses of music in order to test well-defined hypotheses. Such approaches have great potential for answering evolutionary, trans-historical, and cross-cultural questions. Together with a rich understanding of the creative process, these remain central in considering the very nature of the domain of music as a fundamental arena for human creativity.

Many unanswered questions about the nature of musical creativity have particular resonance in the contemporary world. Part of this research program is simply understanding how musical creativity unfolds in a pluralistic, resource-rich, highly interconnected, globalizing culture with numerous stylistic niches available for the expression of musical creativity. Anyone with modern technology can access and assess the tremendous variety of musical styles produced by our species. In previous epochs, this kind of broad comparison was simply impossible; facing this reality raises fundamental questions about the nature of human musical creativity. For instance: What is more impressive, the apparent variability in musical styles or the fact that so many of these styles share basic common features? How does the answer to that question inform how we should think about the human capacity for musical creativity, more broadly? Can musical styles and preferences be arbitrarily modulated by cultural convention blank-slate style, or does the evolved structure of the mind constrain our capacity to create and appreciate certain kinds of music? What are the mechanisms by which changes in musical styles or preferences might unfold over time?

As noted earlier, the complex interplay between these various forces – productive and receptive, biological versus cultural, domain-general versus domain-specific – introduces an inherent long-term tension into the dynamics of high-level musical creativity. Considering music as a fundamental domain of mind suggests that many aspects of human musicality may be inborn. Even quite young infants show sensitivity to many aspects of music and evince systematic musical preferences, and music has been characterized as a natural creative process in the human mind that facilitates expression and communication.

Similarly, numerous regularities are evident across human music worldwide. These include the importance of the octave and other simple pitch ratios like the perfect fifth, categorizing the octave into tones, unequal interval sizes in scales and the tonal hierarchies resulting from them, principles of grouping and meter, and the importance of melodic contour (Justus and Hutsler, 2005). Purves (2017) has suggested that such commonalities reveal that music derives from an evolved capacity to understand spoken language, which is almost unique among ambient environmental sounds in its predominantly tonal quality. The tonal qualities of speech are echoed in regularities across musical styles and tonal systems around the world.

Against this backdrop of evolved preferences, music itself evolves. Quantitative archival studies of melodic originality in the classical repertoire show that melodies tend to become statistically more unusual over time (Simonton, 1994). Moreover, beyond just the note-to-note structure of melodies, numerous other aspects of music have likewise changed over time: in rhythmic and formal patterns, the complexity of counterpoint and instrumentation, relative consonance or dissonance of harmony, level of detail in prescribing aspects of performance, the introduction of multiple styles within a single work, blending of elements from different musical traditions, and so on. These trends have substantial implications for the cultural sustainability of creativity when the imperative for novelty begins to run against the grain of evolutionarily canalized aesthetic preference. Indeed, ambitious creators' rampant pursuit of novelty may greatly outstrip audiences' capacity to appreciate their productions. How this all ultimately plays out is, of course, a mystery.

In any case, human musical creativity continues to emerge from a complex dynamic. Within this dynamic, on one hand, people are constrained due to their evolved biological capacity for musicality, the historical record of musical styles, and larger socio-cultural factors impacting musical creation and consumption. On the other hand, individuals have an equally human capacity for creative innovation. The co-evolution of these factors and faculties promises to keep the study of musical creativity an active area of scholarly and scientific research for the foreseeable future.

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Neuroscience: Cellular Level, Gray Matter, Cellular Density

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Introduction

This entry discusses gray matter structural studies on brain imaging to evaluate creativity as measured by divergent thinking (DT) and other laboratory measurements. In humans, psychometric intelligence is strongly associated with various quantitative structural measures and microstructural properties of gray matter, as shown by structural magnetic resonance imaging (MRI) techniques as described below. In recent years, structural neuroimaging studies have used similar methods to identify correlations between the properties of brain structures and measures of individual creativity to tap the neural sources of individual creativity. In this chapter, these studies are reviewed and their methodologies and implications are described.

Three representative psychological measures for creativity, DT, convergent thinking, and self-report questionnaires are primarily used in the neuroimaging field of the structural bases of individual creativity as described below. However, there are additional approaches including others' evaluations, eminence of the accomplishment, and realistic problem solving.

A brief review of methodological approaches for studying gray matter structures in the brain will be discussed along with the findings.

Creativity Measures

Divergent thinking

In laboratories, creativity is most often measured using divergent thinking tests. For measurement of verbal divergent thinking, the subject is instructed to generate as many ideas as possible in response to a certain question. In figural divergent thinking tests, the subject is presented a picture and is required to respond using their variations of drawing to certain questions and items. Divergent thinking is proposed to be a key aspect of creativity. DT scores are more strongly associated with creative achievement than psychometric intelligence (for a meta-analysis, see [Kim, 2008](#)).

Convergent thinking

Alternatively, creative thinking can be measured by convergent thinking tasks. In such tasks, participants are required to produce a single appropriate answer to a close-ended problem (i.e. a problem that has only one solution). One representative convergent thinking task is the Remote Associates Test. This test aims to assess the ability to identify relationships among remote ideas. In the

task, three seemingly unrelated cue words are presented and the subject is required to provide the fourth word associated with all three words. The test findings showed that creative subjects have higher associative fluency as well as more unusual and flexible associations in these tasks.

Self-Report Questionnaires

Self-report questionnaires can also be used to assess creative achievement or creative activity. One widely used measure is the Creative Achievement Questionnaire (CAQ), which assesses individuals' creative achievements through self-reported information. The CAQ includes items assessing achievement in 10 specific domains, including the visual arts, music, creative writing, dance, drama, architecture, humor, scientific discovery, scientific discovery, invention, and culinary.

Structural Analysis of Gray Matter

There are two well-used approaches to assess gray matter structures: one involves various types of quantitative measurements that are derived from high-resolution structural images and the second method involves the so-called "mean diffusivity", which is measured using "diffusion tensor imaging".

To evaluate associations between individual creativity measures and structural and quantitative measurements of gray matter, high resolution structural images are used to measure (1) regional gray matter volume, (2) regional gray matter density, (3) cortical thickness and (4) surface area. Analyses of regional gray matter volume and regional gray matter density usually employ voxel-based morphometry.

Voxel-based morphometry is a structural processing technique using a brain MRI that involves voxel-wise analysis of correlation between regional gray matter volume or regional white matter density (the probability of the existence of gray matter tissue in a certain area compared with other tissues) and any other factor of interest, such as age or cognitive function (Ashburner and Friston, 2000). In voxel-based morphometry preprocessing, individual structural images are segmented into gray matter, white matter, and cerebrospinal fluid. In voxel-based morphometry, the images from all individuals are registered (fitted) to the same template. In the case of regional gray matter volume, during the registration step, the volumes of the original brain images, before registration to the template, are preserved in the signal strength of the resulting images. For statistical analyses, brain images were divided into small voxels across the entire brain; moreover, regional gray matter volume and density were compared across participants at every voxel. Subsequently, correlations between regional gray matter volume and variables of interest (in the present case, psychological creativity) in each voxel of the brain can be analyzed. Although the exact physiological mechanisms remain unclear, brain volumes are shown to correlate well with representative cognitive functions such as intelligence in normal participants.

Cortical thickness is another quantitative measure of gray matter structures. As shown in Fig. 1 and our previous study (Takeuchi and Kawashima, 2018), cortical thickness is defined as the distance between the white matter and pial surfaces (a surface represents the boundary between gray matter and cerebrospinal fluid). Another measure termed "surface area" is defined as the total area of the white matter surface. The cortical volume of gray matter can be calculated as the product of the cortical thickness and surface area.

These kinds of gray matter quantitative measures are suggested to reflect the number and size of neurons and glial cells, the level of synaptic bulk, and the number of neurites that exist in gray matter. However, this notion must be confirmed by experimental studies. Also, cortical thickness and surface area are shown to have different structural properties and different correlates, each of which can provide unique information.

Structural Analysis of Gray matter—mean diffusivity

As summarized in our review (Takeuchi and Kawashima, 2018), mean diffusivity measures by diffusion tensor imaging can be used to assess the microstructural properties of various brain regions. Diffusion tensor imaging is a method that is sensitive to



Figure 1 Schema of gray matter structural measurements. (Two left panels) Schema of gray matter, white matter, cortical thickness, white matter surface, and pial surface. (Right panel) Schema of mean diffusivity.

the direction of and distance traveled by free water molecules (diffusion) within tissues. The movement of free water molecules can be impeded by tissue microstructures and therefore diffusion tensor imaging can measure the properties of individual tissue microstructures. Mean diffusivity reflects the overall distance traveled by the free-moving water molecules independent of directionality. In a normal brain, lower mean diffusivity represents less free water movement, which is caused by more tissue and cellular structures of various types. These tissue structures may include capillaries, synapses, spines, and macromolecular proteins; properties of myelin, membrane, and axons; the shape of neurons or glia; and enhanced tissue organization. In particular, individual differences in mean diffusivity in the dopaminergic system are associated with various conditions characterized by altered dopaminergic functions.

Associations Between Creativity Measured by DT and Quantitative Measures of Gray Matter

The results of 20 studies of the associations between quantitative measures of gray matter (gray matter volume/density and cortical thickness) and creativity measures are summarized in Fig. 2. We previously summarized the findings of nine studies of associations between creativity measured by DT and quantitative measures of gray matter, and concluded that such findings were mostly not replicated and the associations between creativity measured by DT and quantitative measures of gray matter were elusive (Takeuchi

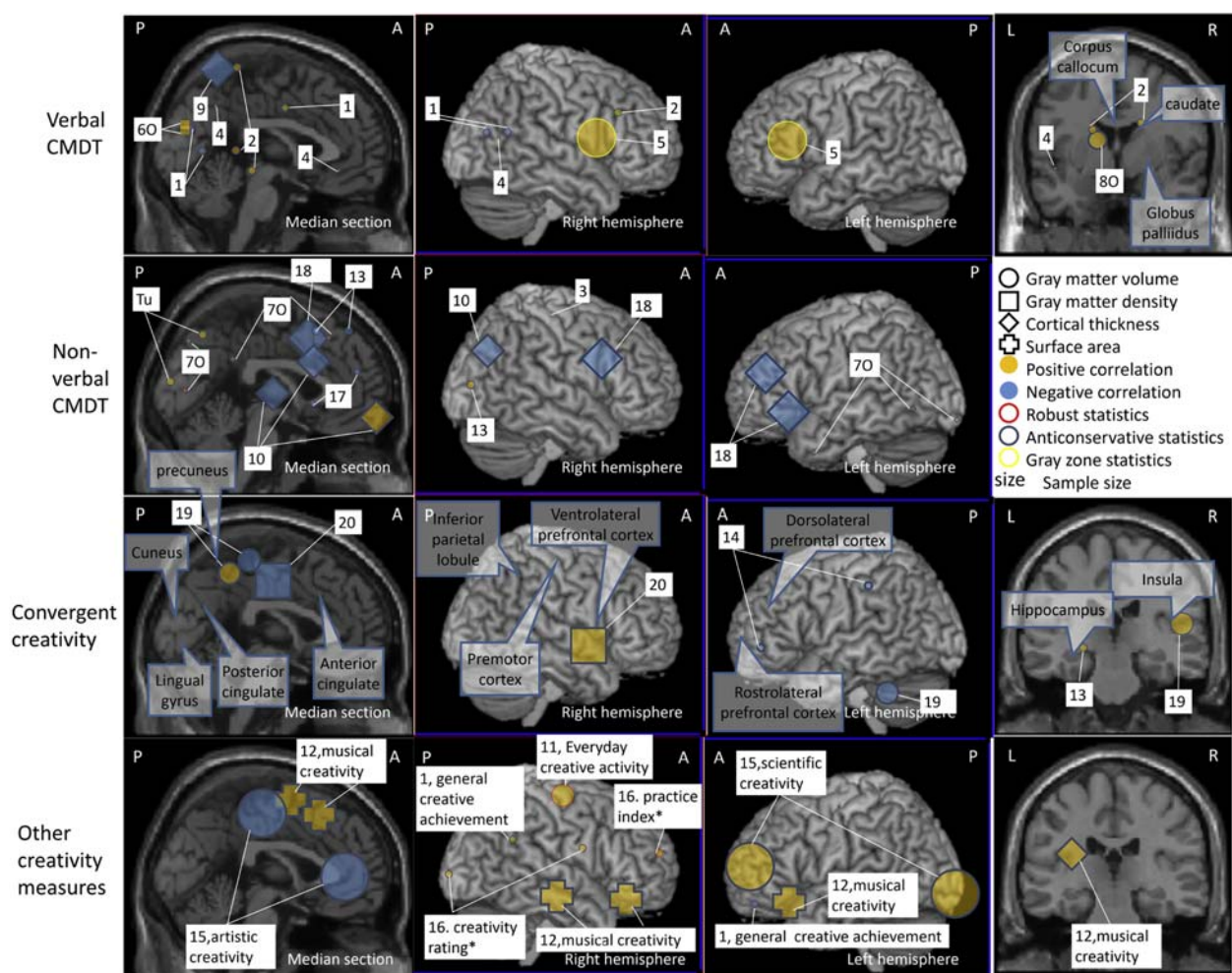


Figure 2 Gray matter correlations with creativity indices. Notes: DT = Divergent thinking. Circles (○) represent findings of GM volume. Squares (□) represent findings of gray matter density. Diamonds (◆) represent findings of cortical thickness. Pulses (+) represent findings of surface area. Orange color within shapes represents a positive correlation, whereas light blue color represents a negative correlation. Marks with red peripheries involved statistical methods that have not been shown to be improper, whereas marks with blue peripheries involved cluster size tests, which have been shown to fail to control the false positive rates in most conditions; however, the conditions of the study seem to fall within conditions under which the test may appropriately control false positive rates (Silver et al., 2012). Marks with blue peripheries involved statistical methods shown to be inappropriate in recent years or statistical approaches that do not correct for multiple comparisons across the whole brain from the beginning, such as region of interest approaches. The width of the marks represents the sample size of each study. The number in the figure is the study number listed in Table 1. "O" represents findings of originality.

and Kawashima, 2018). In this entry, we separated creativity measures into verbal DT, visuospatial DT, measures of convergent creative thinking, and other creativity measures.

As stated, the findings of each study have mostly not been replicated in subsequent studies in this summary of 20 studies. For the four types of creativity measures, the areas of significant associations between creativity measures and gray matter quantitative measures were distributed all over the brain. Although we did not put the information in a figure (as there were no significant results), we previously analyzed the associations between verbal creativity measured by DT and regional gray matter volume in 1336 young adults; using robust statistics, we found no significant associations (Takeuchi and Kawashima, 2019).

We previously suggested possibilities why consistent findings were not seen in studies of the associations between creativity measured by DT and brain quantitative imaging measures (Takeuchi and Kawashima, 2019):

- A Low effect size and widespread results. In neuroimaging studies of associations between individual cognitive differences and quantitative brain measures using several hundred subjects and robust statistics, findings tended to be seen in widespread areas, and single regions did not show mid to large effect sizes ($r > 0.2$).
- B Antinomic nature of creative measures. Creative measures are known to have complex antinomic psychological properties. For example, on one hand, the DT score is associated with greater processing speed, which is associated with greater brain volume. On the other hand, the DT score is also associated with a tendency toward psychosis, which is associated with lower gray matter volume in widespread areas. These measures indicate that certain psychological components of DT tend to associate with higher gray matter volumes, whereas other psychological components of DT tend to be linked with lower gray matter volumes. These complex opposing natures of DT may cancel each other out, and as a result, the associations between creativity measured by DT and gray matter quantitative measures may be tenuous.
- C Complex nature of gray matter quantitative measures. Gray matter volume is, in our opinion, a complex measure. Similar to body volume, multiple factors can increase gray matter volume. For example, use-dependent increases and decreases of gray matter volume following cognitive training have been reported. After adolescence, cortical thinning occurs in many areas of the brain in parallel with cognitive development until at least young adulthood. Advanced cortical thinning is associated with preferable development of cognition. However, neural atrophy is known to decrease gray matter volume. These complex relationships of gray matter quantitative measures may weaken the associations between creative measures and gray matter.
- D Sex differences in neural correlates of DT. Using a large sample size and robust statistics, we previously showed that there are sex differences in the associations between creativity measured by DT and functional and structural connectivity measures. These may exist in parallel with sex differences in psychological correlates of creativity measured by DT. For example, one study reported that the association between creativity and psychopathology differs between sexes, with a stronger positive association seen among men. Several studies have suggested differences in the associations between creativity measures and gray matter quantitative measures in men and women, as well as in healthy controls and patients with bipolar disorder. The differential patterns of associations between creativity measures and gray matter quantitative measures in different groups may weaken associations in analyses involving samples that include various different subject groups.
- E Low statistical power. As there are numerous areas of the brain to be analyzed in the whole brain imaging analyses, the burden for correction of multiple comparisons in statistical tests is tough. Therefore, it generally takes more resources to gather brain imaging data compared with psychological data. As a result, there are likely to be many studies that are lacking in statistical power (sample size) in the field.
- F Inappropriate statistical methods for correction of multiple comparisons. Probably due to the tough burden for correction of multiple comparisons in statistical tests of the vast number of brain areas, several types of “cluster size tests” have been developed and widely used. These tests essentially consider the spatial extent (the size of the areas where the statistical effects are observed at certain thresholds) and strength of the effect when correcting for multiple comparisons. However, in recent years, studies have shown that such tests are not properly controlling false positives in brain imaging, or that the conditions under which they work are very limited. Another statistical method called the (voxel-based) false positive rate may also have problems when applied in brain imaging studies, but has widely been used. We outlined studies that have used such methods in Table 1 and Fig. 2. Studies marked with red-colored peripheries used statistical methods that have not been shown to be improper. Studies marked in yellow used cluster size tests that have been shown to fail to control false positive rates under most conditions, but the conditions of the study seem to fall within the conditions where the test may appropriately control false positive rates (Silver et al., 2012). Most studies used statistical methods shown to be inappropriate in recent years or statistical approaches that do not try to correct multiple comparisons across the whole brain from the beginning, such as region of interest (ROI) approaches (marked with blue peripheries). The use of inappropriate or lenient statistical methods may lead to divergent findings in this field of study.
- G Publication bias or high degree of freedom in methods. Other problems that are common to science are also worth noting. One problem is publication bias, as researchers tend not to publish negative findings and will in fact have difficulty publishing negative findings. Therefore, researchers may tend to report false positive findings instead of true negative findings. We believe these tendencies are particularly common in neuroimaging due to the stringent corrections for multiple comparisons when studying the whole brain. Negative findings are far from null effects and, therefore, it is usually difficult to say something from negative findings. A high degree of freedom in methodologies may also be a source of divergent findings in the field. In the case

Table 1 A summary of characteristics of gray matter structural studies of creativity measures.

Author	N	Creativity measure	Gray matter measure	Statistical test	Reasons for anti-conservativeness of the used statistical tests
1 Jung et al., 2010, Hum Brain Mapp	61 (F: 28)	Verbal DT (verbal TTCT)	Cortical thickness	Cluster size test (Monte–Carlo simulation within FreeSurfer)	Eklund et al., 2016, PNAS
2 Jung et al., 2010, Hum Brain Mapp	61 (F: 28)	Creative achievement (CAQ)	Cortical thickness	Cluster size test (Monte–Carlo simulation within FreeSurfer)	Eklund et al., 2016, PNAS
3 Takeuchi et al., 2010, Neuroimage	55 (F: 13)	Verbal DT (S-A creativity test)	rGMV	Non-stationary cluster size test (cluster determining voxel-level threshold of $p < 0.005$, uncorrected, smoothness of 6-mm FWHM)	Silver et al., (2012), Neuroimage
4 Gansler et al., 2011, Neuropsychologia	18 (F: 0)	Visual DT (figural TTCT)	rGMV	Voxel-level threshold of p -value set at ≤ 0.001 , uncorrected in regions of interest	ROI analysis
4 Kühn et al., 2014, J Creat Behav	21 (F: 16)	Verbal DT (AUT)	rGMV	Non-stationary cluster size test (cluster determining voxel-level threshold of $p < 0.001$, uncorrected, smoothness of 8-mm FWHM)	Silver et al., (2012), Neuroimage
5 Zhu et al., 2013, PLoS ONE	285 (F: 155)	Verbal DT (verbal TTCT)	rGMV	Non-stationary cluster size test (cluster determining voxel-level threshold of $p < 0.0001$, uncorrected, smoothness of 10-mm FWHM)	Silver et al., (2012), Neuroimage ^a
6 Fink et al., 2013, Brain Struct Funct	71 (F: 44)	Verbal DT (AUT, originality)	rGMD	AlphaSim (Monte–Carlo simulation)	Eklund et al., 2016, PNAS
7 Cousijn et al., 2014, PLoS ONE	45 (F: 24)	Visual DT (CAT ¹)	Cortical thickness	Voxel-level FDR	Chumbley and Friston, 2009, Neuroimage
8 Cousijn et al., 2014, PLoS ONE	45 (F: 24)	Verbal DT (AUT)	Cortical thickness	Voxel-level FDR	Chumbley and Friston, 2009, Neuroimage
9 Jauk et al., 2015, Neuroimage	135 (F: 84)	Verbal DT (six tasks)	rGMV	3dClustSim	Eklund et al., 2016, PNAS
10 Chen et al., 2015, Neuropsychologia	268 (F: 143)	Verbal DT (verbal TTCT)	Cortical thickness	Region of interest analyses in significant areas of other analyses	ROI analysis
11 Jung et al., 2015, Front Psychol	246 (F: 119)	Visual DT (foresight task, only stimuli are visual)	Cortical thickness	ROI analyses, $p < 0.005$, uncorrected, 80 contrasts	ROI analysis
12 Zhu et al., (2016), Brain Cogn	163 (F: 93)	Everyday creativity activities (creative Behavior Inventory)	rGMV	Voxel level multiple comparisons (family – wise error)	
13 Bashwiner et al., 2016, Sci Rep	239 (F: 116)	Musical creativity activity (musical creativity questionnaire)	Surface area	Monte–Carlo simulation-based cluster size test	Eklund et al., 2016, PNAS
13 Tu et al., 2017, J Affect Disord	56 (F: 34)	One verbal, two figural DT tasks (ATTA)	rGMV	3dClustSim	Eklund et al., 2016, PNAS
14 Tu et al., 2017, J Affect Disord	56 (F: 34)	Convergent (CWRAT)	rGMV	3dClustSim	Eklund et al., 2016, PNAS
15 Bendetowicz et al., 2017, Cortex	54 (F: 27)	Convergent (CAT ²)	rGMV	Combination of region of interest analyses called small volume correction and cluster size test	ROI analysis Eklund et al., 2016, PNAS

16 Shi et al., 2017, <i>Neurorep</i>	356 (F: 199)	Scientific creative achievements, artistic creative achievements (CAQ)	rGMV	Non-stationary cluster size test (cluster determining voxel-level threshold of $p < 0.001$, uncorrected, smoothness of 10-mm FWHM)	Silver et al., (2012), <i>Neuroimage</i>
16 Neumann et al., (2018), <i>Eur J Neurosci</i>	23 writers (F: 9) and 28 control (F: 14)	Practice index of writing	rGMV	Voxel-level multiple comparisons (family-wise error)	–
17 Neumann et al., (2018), <i>Eur J Neurosci</i>	23 writers (F: 9) and 28 control (F: 14)	Creative rating of writing	rGMV	Region of interest analyses called small volume correction	ROI analysis
18 Xurui et al., 2018, <i>Front Psychol</i>	Interaction between 40 non-artists and 40 artists (F: 47) ^b	Visual DT (Figural TTCT)	rGMV	Non-stationary cluster size test (cluster determining voxel-level threshold of $p < 0.005$, uncorrected, smoothness of 8-mm FWHM)	Silver et al., (2012), <i>Neuroimage</i>
19 Tian et al., 2018, <i>Neurosci Lett</i>	300 (F: 165)	Visual DT (figural TTCT)	Cortical thickness	Cluster size test in AFNI	Eklund et al., 2016, <i>PNAS</i>
20 Ogawa et al., 2018, <i>Sci Rep</i>	162 (F: 74)	Convergent (insight test battery)	rGMV	$p < 0.001$, uncorrected	Lenient threshold
21 Li et al., 2019, <i>Front Psychol</i>	261 (F: 144)	Convergent (RAT)	rGMD	AlphaSim (Monte–Carlo simulation)	Eklund et al., 2016, <i>PNAS</i>

ATTA, Abbreviated Torrance Test for Adults; AUT, Alternative Uses Test; AFNI, Analysis of Functional NeuroImages; CAQ, Creative Achievement Questionnaire; CAT¹, Creative Ability Test; CAT², Combined Associative Task; CWRAT, Chinese Word Remote Associates Test; DT, Divergent thinking; FWHM, Full width at half maximum; ROI, Region of interest; rGMD, regional gray matter density; rGMV, regional gray matter volume; TTCT, Torrance Tests of Creative Thinking.

^aNon-stationary cluster size was shown to be mostly invalid; however, under conditions of high smoothness of imaging data, more stringent cluster determining voxel-level threshold, and higher degrees of freedom, it tends to work (Silver et al., 2012).

^bThe interaction effects are seemingly driven by effects in the non-artist group.

of associations between neuroimaging measures and creativity measures, there are many degrees of freedom in how we preprocess obtained structural images and what measures (gray matter density, gray matter volume, cortical thickness) we use. Further, in the case of DT, instructions regarding the focus on quality, quantity, and scoring methods are known to affect the properties of DT measures. These factors may result in diverse findings.

Among such findings, there are several points worth noting. First, among the divergent findings, posterior midline structures—including the precuneus/cuneus and posterior cingulate cortex—tend to have significant findings (although the significant correlations are positive correlations in some studies, whereas they are negative correlations in other studies). These areas gather information from a wide range of brain regions and contribute to visual and mental imagery, self-related mental representations, and episodic memory retrieval. All of these cognitive processes likely contribute to creativity. The associations between DT performance and brain structures from the areas involved in visual and mental imagery and episodic memory may be consistent with the psychological findings because even verbal DT is positively associated with visual mental imagery ability.

Furthermore, five studies reported that visuospatial creativity measured by DT and artistic creative achievement measured by questionnaires showed negative correlations with gray matter quantitative index in regions of the anterior cingulate cortex (Fig. 2). Although the various subregions of the anterior cingulate cortex have many function, one important role of this area relevant to creativity is focused attention (Gasquoin, 2013).

Various studies have suggested that creativity is associated with leaky attention or unfocused attention. For example, psychological studies have shown that creative subjects are insufficient in dealing with a selective attention task, bad at ignoring irrelevant external stimuli, and bad at suppressing unattended information processing (Necka, 1999). Therefore, associations with reduced quantitative measures of gray matter and visuospatial or artistic creative measures (if any) may be relevant to this area's role in attention. Further, while it is known that vulnerability to psychosis is associated with creativity, this vulnerability is also associated with reduction of gray matter quantitative measures. Therefore, the psychological profile of creative subjects may account for the observed associations between gray matter and creativity measures in this area.

Furthermore, a handful of studies showed associations between creativity and quantitative gray matter in areas in the lateral prefrontal cortex. For example, the writing practice in writers and controls was shown to be positively correlated with regional gray matter volume in the rostrolateral prefrontal cortex using robust statistics (known as voxel-level family-wise error correction) (Neumann et al., 2018) (red circle in Fig. 2). The rostrolateral prefrontal cortex is involved in evaluation of internally generated information, as well as successful task completion that requires problem solving in two or more domains and successful coordination of two or more cognitive operations. In addition, this area is activated during creative story generation (Howard-Jones et al., 2005). These cognitive processes subserved by the rostrolateral prefrontal cortex may thus contribute to creativity.

On the other hand, everyday creative behaviors (engagement in literary, performing, and visual arts and crafts) were shown to be positively correlated with regional gray matter volume in the right premotor cortex using a robust correction for multiple comparisons method called voxel-level family-wise error correction (Zhu et al., 2016) (red circle in Fig. 2). This right premotor cortex is involved in planning and selecting novel actions, as well as higher order cognitive processes including a number of verbal and visuospatial creative activities.

Other regions of the lateral prefrontal cortices are suggested to play important unique roles in creativity. For example, the dorsolateral prefrontal cortex is involved in cognitive abilities, such as working memory, sustained attention, cognitive flexibility, and fluency in the generation of ideas and judgments of appropriateness, which contribute to creativity. The ventrolateral prefrontal cortex plays a key role in internal speech (a person's inner voice which provides a continuous verbal monologue of thoughts) and lesions in this area lead to a deficit in speech production, which in turn leads to reduced linguistic output (Flaherty, 2005). This condition is suggested to be similar to creative block—particularly writer's block.

However, studies on artistic development in patients with frontotemporal dementia suggest that language may inhibit certain types of visual creativity (Mell et al., 2003). Transcranial direct current stimulation (tDCS) studies have shown that inhibitory stimulation of the left ventrolateral prefrontal cortex facilitates generation of creative responses as well as creativity measured by DT (Maysseless and Shamay-Tsoory, 2015). Therefore, the associations between the ventrolateral prefrontal cortex and creativity appear to be complex and inconclusive.

Mean Diffusivity Findings

We conducted two studies of mean diffusivity related to verbal creativity measured by DT. In one study, we showed that the major personality traits exhibiting robust associations with creativity measured by DT showed strong correlations with mean diffusivity in the bilateral pallidum. Further, we showed that verbal creativity measured by DT is indirectly associated with mean diffusivity in the pallidum via the associations of these personality traits.

Specifically, lower mean diffusivity in the right pallidum was associated with greater novelty seeking, lower harm avoidance (personality characterized by excessive worrying, pessimism, shyness, and being fearful, doubtful, and easily fatigued), greater self-directedness (personality trait of self-determination, i.e., the ability to regulate and adapt behavior to the demands of a situation to achieve personally selected goals and values), and greater self-transcendence, which are in turn associated with greater verbal creativity measured by DT. Furthermore, lower mean diffusivity in the left pallidum was associated with greater

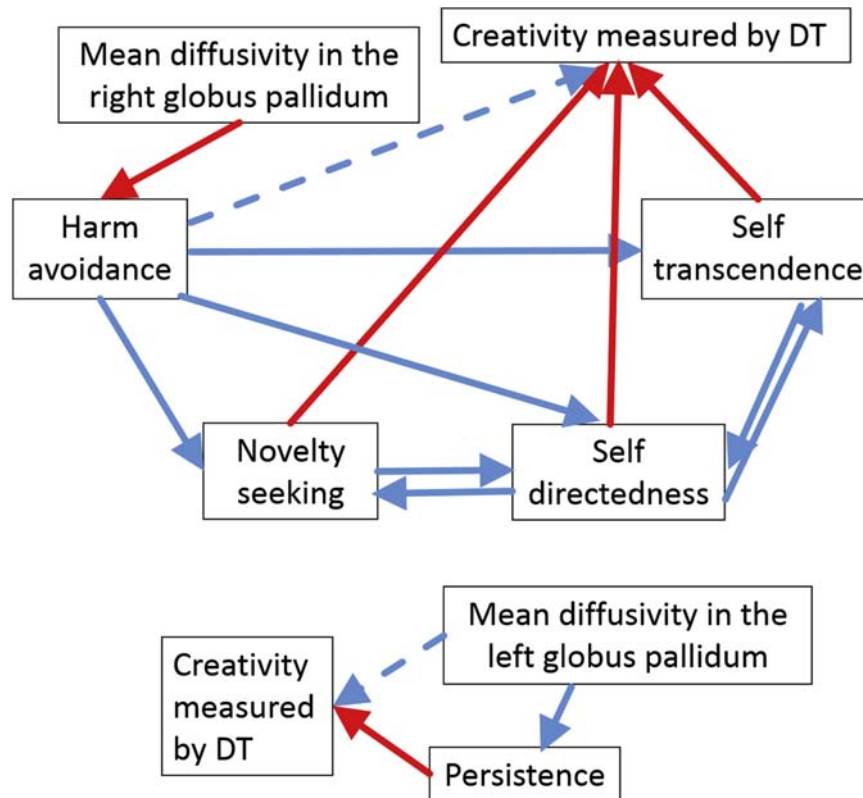


Figure 3 Schema of the models of associations among creativity measured by DT, personality, and mean diffusivity in the bilateral globus pallidus, which was suggested in our previous study (Takeuchi et al., 2015). Notes: DT = Divergent thinking. Red arrows indicate positive effects, whereas blue arrows indicate negative effects. Dotted lines indicate cases wherein the model with the existence of the path fit the model best, but the path failed to reach significance. Bidirectional arrows indicate models in which both directions fit the data equally.

persistence (personality characterized by perseverance despite frustration and fatigue, as well as a tendency toward a persistent pursuit of desired goals), which in turn is associated with greater verbal creativity measured by DT (Fig. 3) (Takeuchi and Kawashima, 2018).

When an affective state is finely divided, unlike other affective states, the greater motivational state (state of vigor) is also associated with lower mean diffusivity in the right globus pallidus (shown using robust statistics), as well as verbal creativity measured by DT. This greater motivational state was also found to be associated with greater novelty seeking, lower harm avoidance, greater self-directedness, greater self-transcendence, and greater persistence. In another study, we showed that mean diffusivity of the right globus pallidus was negatively correlated with extraversion (, while greater extraversion was positively associated with greater divergent thinking abilities. These findings suggest robust associations between mean diffusivity of the globus pallidus and traits and states associated with creativity measured by DT. Takeuchi and Kawashima, 2018).

The globus pallidus and adjacent areas are suggested to play a key role in motivation. It is possible that increased tissue in the globus pallidus may be associated with greater motivation, and this association could help explain the associations between several traits that underlie creativity measured by DT and mean diffusivity in the globus pallidus.

As summarized similarly previously, physiologically, the globus pallidus receives dopaminergic input from the substantia nigra and is related to dopaminergic function. A wide range of psychological studies support associations between creativity measured by DT or other creativity measures and dopaminergic function. For example, there are associations between creativity measured by DT and traits related to dopaminergic function, such as schizotypy, novelty seeking, and extraversion, as described above. Interestingly, the pathological condition of dopaminergic dysfunction leads to loss of creativity, and artistic creativity in such pathology is recovered by use of dopamine agonists, while dopamine antagonists are known to suppress creativity.

Creativity is also associated with greater motivation, which is associated with dopaminergic functions. Based on our previous review of the mean diffusivity literature, we concluded that mean diffusivity in the dopaminergic system is associated with a wide range of psychological, pharmacological, and pathological conditions related to functional alterations in the dopaminergic system. Therefore, the observed associations between mean diffusivity of the globus pallidus and a wide range of psychological traits and states associated with creativity measured by DT may be partly behind the traditional idea that creativity and dopaminergic function are linked.

Overall Discussion

Overall, the associations between creative measures and quantitative measures of gray matter are divergent and elusive at best. Particularly, we failed to find significant associations between regional gray matter volume and verbal creativity measured by DT using a large sample size and robust statistical methods. We cited possible reasons for this phenomenon. However, potential associations involving posterior midline structures, such as the precuneus and posterior cingulate cortex, anterior cingulate cortex, and areas in the lateral prefrontal cortex, are suggested.

Using a large sample size, we found consistent associations of mean diffusivity of the globus pallidus with traits and states associated with creativity measured by DT, and suggested the importance of motivation for these associations. We suggest that these findings might underlie the suggested link between dopaminergic function and creativity.

By reviewing studies of associations between individual cognitive differences and neuroimaging measures in young adults, we concluded that the associations are generally very weak. Larger sample sizes and robust statistical methods are needed to generate more reliable findings in the field.

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Neuroscience: The Cerebellum's Predominant Role in Creativity

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The Role of the Cerebellum in Thought and Creativity: A Monumental Neuroscience Breakthrough

Three decades ago, leading cerebellum researchers proposed that just as the cerebellum contributes to the refinement and automaticity of motor skills, the cerebellum's connections to the prefrontal cortex and Broca's language areas (areas 44 & 45) contribute to planning and language. In essence, they proposed that, 'operating below the level of conscious awareness,' the cerebellum contributed to increased levels of thought in the following way:

Cerebellar connections to Broca's area may not only increase the speed and skill of speaking but also confer other benefits on humans. Because Broca's area communicates with other association areas in the cerebral cortex, the cerebellar signals to Broca's area could increase the speed and skill of such intracortical communication. These communications between cortical association areas are said to comprise the language of thought (Luria, 1980). Therefore, the processes of rationale thought may be performed with increased speed and skill in the human brain as a consequence of its enlarged cerebro-cerebellar connections. (1989, 1006)

In the time since the publication of this breakthrough research, it has been further established that the cerebellum indeed does participate greatly in language and thought.

The Cerebellum Plays a Prominent Role (Perhaps a Predominant Role) in Driving People to Be Creative

The language and thought functions of the cerebellum described in the above quote evolved primarily during the last million years. Because the cerebellum has the key role in refining *all* of our specific skills, including mental skills, neuroscience researchers have argued that part of this refinement process by the cerebellum is to produce new and useful ideas and technology. In other words, the cerebellum drives people to be creative. Moreover, it has been proposed that it was the evolution of the new language and thought functions of the cerebellum that was largely responsible for driving the advanced stone-tool technology and culture of *Homo sapiens* into existence.

The Neural Mechanisms by Which the Cerebro-Cerebellar System Produces Potentially New and Useful Ideas, Objects, Technology and the Arts

It is now established that through the 'repetition' of motor skills, thoughts and related emotions, the cerebellum 'optimizes' the usefulness, speed, and appropriateness of 'internal models' it learns and constantly sends them back to the cerebral cortex toward the increasingly efficient achievement of goals. [Cerebellar internal models are called internal models, because they are neural representations (models) of processes going inside the rest of the brain.] For example, a basketball player repeatedly shoots baskets and through this practice soon becomes very skilled at making baskets from a variety of locations. The basketball player may even

develop innovative and creative signature moves that result in making baskets in perhaps situations of unheard of difficulty. As a more thought- and language-based example, teachers and professors, after repeating their lectures many times, often no longer need their notes and can give their lessons in many innovative and creative ways on the fly, much as a well-practiced musician can easily carry on conversations or improvise in new directions during the playing of a musical piece. Dedicated practice among even musical child prodigies relies on cerebro-cerebellar loops to reach errorless levels of performance including improvisation at a very early age, usually under age 10. [Vandervert and Vandervert-Weathers \(2013\)](#) described how prototyping in the classroom can take advantage of cerebro-cerebellar processes to produce higher levels of practical innovation and creativity, for example, in prototyping that leads to new technology. In all of these examples, the cerebellum silently (below the level of conscious awareness) learns highly efficient internal models of repetitive ideas and activities.

Four Ways the Cerebellum Has Been Shown to Drive Creative Optimization

It is now thought that, through socialization, the cerebellum learns to automate and optimize repetitive, routine patterns of thought and behavior that are constantly going on around us; thus, we unconsciously (for the most part) participate in culture (see Relevant Websites). However, the cerebellum can also be shown to be prominent in the learning of not only everyday skills but additional optimizations that lead to the production of creative ideas. The cerebellum accomplishes this production of new and useful ideas in at least four ways. First, the cerebellum orchestrates the 'decomposition' of motor and mental skills that have been learned in the cerebral cortex so that they then may be sent back to the cerebral cortex in new forms that help achieve new goals. Second, through constant 'error-correction' the cerebellum optimizes motor and mental skills that have been re-organized (blended) in the cerebral cortex; although these new blends originate in the cerebral cortex, this cerebellar optimization of these blends may bring these skills to levels where they result in new and useful ways of doing things and/or thinking about things. Third, the cerebellum learns its optimizations below the level of conscious awareness. Fourth, therefore, because new optimizations are learned unconsciously, when wholly new blends (new ideas) are sent to the cerebral cortex, they may be experienced as insight or 'intuition.' This overall, four-part process may be referred to as cerebellum-driven 'creative optimization.'

Cerebellum-Driven Unconscious Optimization Makes New Ideas Seem to Come From Nowhere

Cerebellum researchers have convincingly argued that, taken together, the four above-described cerebellum-driven processes can explain the common experience wherein one may not know how they learned a new signature move in sports, or how they came to stumble upon an insight that led to a creative idea, new artistic expression, or marketable high-tech product. That is, because such cerebellum-driven creative experiences and new, unique skills are the result of optimization processes which operate below the level of conscious awareness, they seem to our conscious experience to suddenly come out of nowhere!

The 'Sequential' Computations of the Cerebellum Both Optimize and Predict Our Ability to Achieve Future Goals, Including Imaginary Goals

How, exactly, does the cerebellum participate in creating new and useful ideas, art, and technology? What is the nature of its magic? Two independently working research teams zeroed in on the nature of the computations that lead the cerebellum to predict and anticipate what is coming next during all problem solving. This work revealed the universal neural platform of unlimited cause-and-effect analysis leading to new, progressively more refined solutions to problems. A leading team of cerebellum researchers referred to these computations, called sequence detection, as the cerebellum's 'trick for predicting the future.'

The first team in proposing this view, [Akshoomoff et al. \(1997\)](#), concluded that thought and motor control (among other processes they list) are unconsciously learned in the cerebellum through the detection of ordered sequences going on in all movement and thought:

The cerebellum is a master computational system that adjusts responsiveness [toward optimization] in a variety of networks to obtain a prescribed goal [including imaginary goals related to better ways of doing things]. These networks include those thought to be involved in declarative memory, working memory, attention, arousal, affect, language, speech [Broca's area], homeostasis, and sensory modulation as well as motor control. This may require the cerebellum to implement a succession of precisely timed and selected changes in the pattern or level of neural activity in these diverse networks. We hypothesized that the cerebellum does this by encoding (learning) temporally ordered sequences of multi-dimensional information about external and internal events (effector, sensory, affective, mental, autonomic), and, as similar sequences of external and internal events unfold, they elicit a readout of the full sequence in advance of the real-time events [this readout is the basis of progressively more detailed cause-and-effect relationships and thus broader and more detailed prediction]. This readout is sent to and alters, in advance [italics added], the state of each motor, sensory, autonomic, attentional, memory, or affective system which, according to the previous learning of this sequence, will soon be actively involved in the current real-time events. So, in contrast to conscious, longer time-scale anticipatory processes mediated by cerebral systems, output of the cerebellum provides moment-to-moment, unconscious, very short time-scale, anticipatory information. (p. 592–593)

This quote simply states that through the detection and predictive encoding of problem-solving sequences, the cerebellum is able to unconsciously predict (anticipate) good and often new solutions to problems before they occur. Vandervert (2018) described how, over repetitions of thought and movement, this sequence detection process in the cerebellum peers deeper and deeper into cause-and-effect relationships.

Predictive information produced by the above-described predictive sequences of information includes constant error-correction (leading to optimization) of future movements and thoughts. This error-correction unconsciously achieves goals at progressively higher levels, and this includes goals related to purely imaginary future accomplishments. For example, in learning to shoot baskets, play the piano, or for a professor to give a university lecture, the sequence detection process notes errors in movements and thoughts and *automatically* modifies them for its next anticipatory response. Recall from earlier in this discussion that, in this process, behavior and thought are constantly being decomposed and re-organized by the cerebro-cerebellar system to more efficiently solve the problem at hand and to solve problems in new ways. Since these cerebellar processes also take place in thought that takes place in working memory, this error-correction toward more efficient problem solving applies to both online, real-time problem solving and cerebellar memory consolidation during sleep. More broadly, this means that when we are thinking about other problems, encountering unrelated experiences, or even sleeping the four mechanisms of cerebellum-driven creative optimization are at work! This exclusive, silent 'cerebellum time' away from a specific problem we have been working on would define and produce, in neural terms, the *incubation* phenomenon (Wallas, 1926) that deems facilitative if not necessary to creativity.

Further Evidence of Cerebellar Prediction Through Sequence Detection

The cerebellum's predictive sequence detection in working memory is more clearly shown by the findings of Leggio and Molinari (2015), the second team of cerebellum researchers to zero in on the nature of the computations of the cerebellum. Their findings led them to the following hypothesis on how, through sequence detection, the cerebellum 'simulates' future states of affairs and higher order mental processes:

According to this hypothesis, the cerebellum detects and simulates repetitive patterns of temporally or spatially structured events [sequence detection], regardless of whether they constitute sensory consequences of one's actions in motor planning, expected sensory stimuli in perceptual prediction, or inferences of higher-order processes (e.g., 'cognitive elaboration' [quotes added] or social cognition). The simulation allows internal models [in the cerebellum] to be created that can be used to make predictions about future events that involve any component, such as the body, other persons, and the environment. (p. 36)

The purpose of including this quote here is twofold. First, it supports Akshoomoff et al. (1997) conclusion that the cerebellum's main job is to optimize the preparation of cognition and movement to meet future circumstances. Second, it strongly supports the contention that silent (unconscious) prediction by the cerebellum applies to the highest levels of 'cognitive elaboration.' (The 'simulation' process mentioned by Leggio and Molinari constitutes the learning of cerebellar internal models.)

It is important to emphasize that while not only are Leggio and Molinari (2015) above findings are completely in agreement with Akshoomoff et al. (1997) earlier findings, but they were arrived at independently and through a different research approach. This fact gives high credibility to both teams' conclusions that the cerebellum is key to producing (in a predictive manner) new, workable solutions to difficult problems, including those involving higher-order processes of cognitive elaboration and social cognition that are commonly associated with innovation and creativity. The final section of this article will return to a description of how cerebellum-based prediction can be related to the unique, high-level creativity (a part of cognitive elaboration) of Albert Einstein.

Perplexing Historical Examples of Extreme Creativity Which Can Be Addressed by the Cerebello-Cerebral Approach

Understanding the Role of the Cerebellum in Einstein's Creativity

Albert Einstein was a keen observer of not only the complex relationship between time and space but of how such new ideas emerged within his own experience, and he often wrote about it. Einstein argued in many of his writings that new ideas in science, including his own, were the result of 'unconscious' processes that give rise to intuition. For example, in a 1949 personal letter to fellow physicist H. L. Gordon,¹ he provided a complete picture that connected the unconscious and intuition, and intuition's relation to previous intellectual experience and their combined relationship to new ideas:

A new idea [a new concept] comes suddenly and in a rather intuitive way. That means it is not reached by conscious logical conclusions. But thinking it through afterwards you can always discover the reasons which have led you unconsciously to your guess and you will find a logical way to justify it. Intuition is nothing but the outcome of accumulated earlier intellectual experience.¹

¹Albert Einstein letter to Dr. H. L. Gordon, May 3, 1949. This is Item 58–217 in the Control Index to the Einstein Archive which may be consulted at Mudd Library, Princeton University.

Vandervert (2015) proposed that Einstein's unconsciously driven intuition was produced when the cerebellum sent its unconscious, newly formed internal models to conscious areas of the cerebral cortex, for example to the prefrontal and parietal areas. The repetitive experience necessary to this cerebellum-driven intuition was noted by Einstein. In his Autobiographical Notes, he recalled how he hit upon the idea of his special theory of relativity only after 10 years of repeated reflection on unsolved scientific problems related to motion.

Seven years later, in a personal letter to his long-time friend Maurice Solovine, he emphasized his point on the necessity of intuition in the creative discovery of new axioms in science. In his explanation, he began with immediate experience (E) and then described a necessary intuitive leap of creative discovery to the axioms (A):

A are the axioms from which we draw consequences. Psychologically the A are based upon the E. There is, however, no logical path from the E to A, but only an intuitive (psychological) connection, which is always subject to revocation.

Einstein (1956), pp. 118–121.

Einstein's above closing comment that intuitive connections are "always subject to revocation" fits findings on cerebellum-driven intuitive leaps which are the result of sequence detection as described earlier in this entry. That is, according to Akshoomoff et al. (1997) and Leggio and Molinari's (2015) findings on cerebellar prediction and anticipation, the cerebellum, operating below the level of conscious awareness, constantly adjusts to new experience in a manner that updates the optimization of prediction and often updates these optimizations in the form of wholly new concepts. It is suggested that this cerebellar production of wholly new ideas is the evolutionary advantage that drove the generation-upon-generation of creativity behind the evolution of stone-tool technologies and of language among the genus *Homo*, particularly *Homo sapiens*.

In his day, it was a puzzle for even Einstein as to how thought processes in the brain might produce intuitive solutions to deep problems, solutions that in his case would dramatically change the face of theoretical physics. However, Einstein's above arguments that new and useful ideas even in theoretical physics come about only through intuition which is (1) based upon the accumulation of experience, but, at the same time, (2) is arrived at unconsciously squares well with the more recently discovered cognitive functions of the cerebellum described here. Specifically, Einstein's analysis comports well with Vandervert's (2003) and (2015) proposal that, operating below the level of conscious awareness, internal models learned through the repetitive accumulation of experience in the cerebellum are sent to the cerebral cortex where they are experienced as sudden, intuitive insights. Such intuitive insights may provide new and useful solutions to problems, arguably the basis of all creativity.

How do such intuitive insights produce new ideas that, as in Einstein's case, can change the face of physics? Vandervert (2018) proposed that since through its optimized error-correction the cerebellum constantly refines both the level of detail and applicability of all cause-and-effect relationships, the cerebro-cerebellar system supports not only all skilled movement and thought but, within that thought, deeper and broader scientific models of the physical universe. And, as Einstein suggested in his above quotes, these new ideas can only be arrived at through unconsciously-driven intuition.

Conclusions

Cerebellar decomposition and blending of concepts and skills take place during unconscious incubation that leads to creativity (Vandervert, 2015).

The cerebellar refinement of cause-and-effect relationships provides an explanation of how unconsciously-driven intuition can reveal new scientifically verifiable laws of nature (Vandervert, 2018).

Cerebellum-driven creativity is the neural mechanism behind both the origin and ongoing relentless advance of culture (Vandervert, 2018).

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Further Reading

The cerebellum, science and Einstein: <https://cerebellumandataxias.biomedcentral.com/articles/10.1186/s40673-015-0030-2>.

Relevant Websites

The Cerebellum's Prominent Role in the Learning of Culture: <http://blogs.biomedcentral.com/on-biology/2016/05/11/prominent-role-cerebellum-development-culture/>.

The Cerebellum and the Child Prodigy: <http://blogs.biomedcentral.com/on-biology/2016/06/01/child-prodigies-1000000-years-silently-making/>.

Einstein's Relativity Theory and the Cerebellum: <http://blogs.biomedcentral.com/on-biology/2017/05/25/the-cerebellum-a-new-horizon-for-brain-studies-of-the-genius-of-albert-einstein/>.

https://www.researchgate.net/profile/Larry_Vandervert.

Neuroscience: EEG

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EEG: Basic Concepts and Measures

Electroencephalography (EEG) is a neuroscience method to measure the electrical activity of the cortex. When larger assemblies of neurons act synchronously, brain potentials with amplitudes of up to several 100 μV can be observed. These brain potentials can be recorded with electrodes placed at the scalp. The EEG is characterized by brain oscillations occurring at specific, preferred frequency ranges, which has led to the discrimination of distinct frequency bands (Klimesch, 2018). Alpha activity refers to EEG oscillations in the range of about 8–13 Hz, beta activity refers to EEG oscillations in the range of about 14–30 Hz, and gamma activity refers to EEG oscillations of about 30–100 Hz (usually around 40 Hz). Slower oscillatory activity is reflected in delta activity (0.5–4 Hz) and theta activity (5–7 Hz). Frequency analysis techniques (e.g. fast Fourier transform) are used to compute the power of specific frequencies or frequency bands in the EEG signal over time. EEG can be measured with very high temporal resolution (e.g., 1000 Hz), whereas spatial resolution is restricted. EEG activity mainly reflects cortical brain activity, and spatial resolution is further limited by the number of electrodes (commonly 20–64) and by the fact that nearby electrodes measure overlapping signals. Yet, source localization techniques can be applied to recover the actual sources of EEG activity within the brain (Koles, 1998).

One common approach in EEG research is the analysis of task-related power (TRP) changes elicited by a cognitive task relative to a pre-task baseline. Increases and decreases in frequency-specific power are referred to as synchronization and desynchronization, respectively. For example, if one observes decreases/increases of alpha power from a pre-task baseline to a task period, then this is called alpha de/synchronization (speaking of events, it is called event-related de/synchronization; ERD/S; Pfurtscheller and Silva, 1999). Brain oscillations can also be used to study functional connectivity across cortical sites. Common measures of brain connectivity include coherence and phase-locking. EEG coherence essentially reflects the correlation between signals from different electrode positions, whereas phase-locking reflects the synchrony of phases between signals independent of their amplitudes. These brain connectivity measures represent indicators of inter-regional coupling, which reflects covariation of brain activation, and potentially indicates causal dynamics between local brain networks.

Another analysis popular approach in EEG research is the analysis of event-related potentials (ERPs). Psychological events elicit a characteristic sequence of positive and negative potential changes within about 1 second after the onset of the event. For instance, the P300 denotes a positive peak of brain potential commonly occurring about 300 ms after event onset. These potentials are very small but can be observed reliably after aggregating EEG signals across many trials. Several ERP components are commonly observed (e.g., P50, N100, P200, P300) and have been related to different sensory, cognitive and motor processes. Studies typically compare effects of experimental conditions on the amplitudes of different ERP components.

How to Study Creativity With EEG

EEG is arguably the first neuroscientific method ever applied to the investigation of creativity, with research going back to the 1970s. To date, about half of the available neuroscience studies on creativity have been carried out with EEG, while the other half predominantly employed Magnetic Resonance Imaging (MRI). EEG assessments are largely unobtrusive as they only require participants to wear an electrode cap, but do not restrict body position and movement as much as other methods (e.g. MRI), which allows to study EEG brain activity across a wide range of creative activities. An analysis of 63 available EEG studies on creativity (Benedek et al., 2019) showed that 54% of studies employed divergent thinking tasks (i.e., idea generation tasks), 21% employed convergent thinking tasks (i.e., creative problem solving requiring one solution), and the remaining 25% employed more realistic, product-based tasks such as musical improvisation and imagined or actual drawing. These rates are

very similar to those observed in behavioral research on creativity, which suggests that creativity tasks that are popular and well-established in behavioral research, frequently get adopted by EEG research.

Studying creativity with EEG still requires certain adaptations to meet the requirements of neurophysiological measurements. Importantly, EEG studies on creativity commonly separate time periods of idea generation and actual response production in order to avoid confounds between brain activation data and motor artifacts. This can be achieved in different ways: One common way is to instruct participants to push a button when they come to a solution and only then express their idea. This method allows for self-paced task performance, while enabling experimenters to carry out a post-hoc separation of ideation and response periods relative to button presses [Fink et al. \(2007\)](#). Another common way is to use fixed ideation and response periods, which implies higher experimental control, but requires to specify reasonable task durations that enable valid performance across all tasks (overly short tasks may fail to yield responses, whereas overly long tasks may result in idling). Finally, few studies have measured EEG during actual creative response production (e.g., musical improvisation). These studies control for artifacts by implementing adequate control conditions and making use of effective artifact correction procedures (a more detailed discussion of methodological considerations in the neuroscientific assessment of creativity is given in [Benedek et al., 2019](#)).

Main Findings of EEG Research on Creativity

Investigations of Oscillatory Brain Activity

EEG alpha activity. Investigations of EEG oscillatory activity in creativity have commonly focused on alpha activity, which is the dominant frequency in the human EEG ([Klimesch, 2012](#)). Early work found that EEG alpha activity was higher during the imagination of a creative story as compared to a later period when a story was elaborated and written down. Similarly, people who were more creative exhibited higher alpha activity than less creative people during various cognitive tasks. These findings suggested that creativity is related to higher alpha activity, which was interpreted as evidence that creativity involved lower cortical arousal ([Martindale, 1999](#)).

The positive relationship between creativity and EEG alpha activity has been replicated across many tasks and designs. Specifically, alpha synchronization was found to be higher during tasks with high vs. low creative task demands (e.g. generating creative object uses vs. generating typical object characteristics). Moreover, the generation of more creative ideas was associated with higher EEG alpha activity than the generation of less creative ideas. Studies looking at individual differences found higher task-related alpha synchronization for more creative people compared to less creative people. Finally, EEG alpha activity was increased by creativity training and cognitive stimulation. Most notably, recent evidence suggests that transcranial alternating current stimulation (tACS) in the alpha frequency range increases creative performance. Together, these findings demonstrate a robust positive relationship between creativity and EEG alpha activity (for reviews, see [Fink and Benedek, 2013, 2014](#)). Creative cognition is particularly characterized by alpha synchronization at frontal cortical sites and in posterior regions of the right hemisphere, and by reduced alpha desynchronization at occipital sites (see [Fig. 1](#)).

The robust relationship between creativity and EEG alpha activity raises the question about the functional role of EEG alpha in creative cognition. First of all, it is notable that EEG alpha activity is not only higher in more creative tasks but was found to actually increase relative to a pre-task baseline. This seemed paradoxical at first, given that the traditional interpretations of alpha activity assumed it reflects states of reduced brain activation or “cortical idling.” Other accounts proposed that EEG alpha reflects active top-down inhibition of task-irrelevant brain regions and related it to states of internally directed attention. In fact, parallel studies of creative cognition with EEG and fMRI showed that increased alpha activity in the EEG relates to increased brain activation as measured by the BOLD response in fMRI, suggesting that alpha synchronization represents states of increased rather than reduced brain activity. Further studies showed that more and less creative tasks actually show similar alpha activity when they are matched for sensory demands, and that alpha activity increases in both tasks when they are carried out with reduced sensory input as during task performance in the mind’s eye. Moreover, alpha activity was generally higher for tasks that were intrinsically independent of sensory stimulation compared to tasks that relied on bottom-up stimulus processing ([Benedek et al., 2011; Benedek et al., 2014](#)).

These findings indicate that the creativity-alpha relationship can be explained by the high internal attention demands involved in creative cognition. Creative thought crucially relies on imagination, which is characterized by self-generated, stimulus-independent thought processes such as the generation of novel mental representations and mental simulations, while disregarding irrelevant sensory input. Alpha activity at frontal and posterior brain sites hence seems to represent a top-down gating mechanism to shield ongoing internally-directed processes (i.e., imagination) from sensory interference. This notion was supported by an fMRI study showing that internal attention during creative thought involves reduced activation of the primary visual cortex, which was mediated by activation of the right inferior parietal cortex – the brain region where alpha activity shows the most robust increases during creative thought ([Benedek et al., 2016](#)). Moreover, idea generation and moments of insight are associated with visual disengagement as evidenced by gaze aversion, increased blinks, and reduced microsaccade activity in eye-tracking research ([Salvi and Bowden, 2016; Walcher et al., 2017](#)). Taken together, EEG alpha activity can be viewed as a sensitive neurophysiological indicator of internally-directed attention, likely reflecting the level of absorption by ongoing imagination processes during creative thought ([Benedek, 2018](#)).

The high temporal resolution of EEG activity has been further exploited in the study of temporal dynamics in creative cognition. For example, investigations of EEG activity over the course of creative problem solving observed transient alpha activity increases at

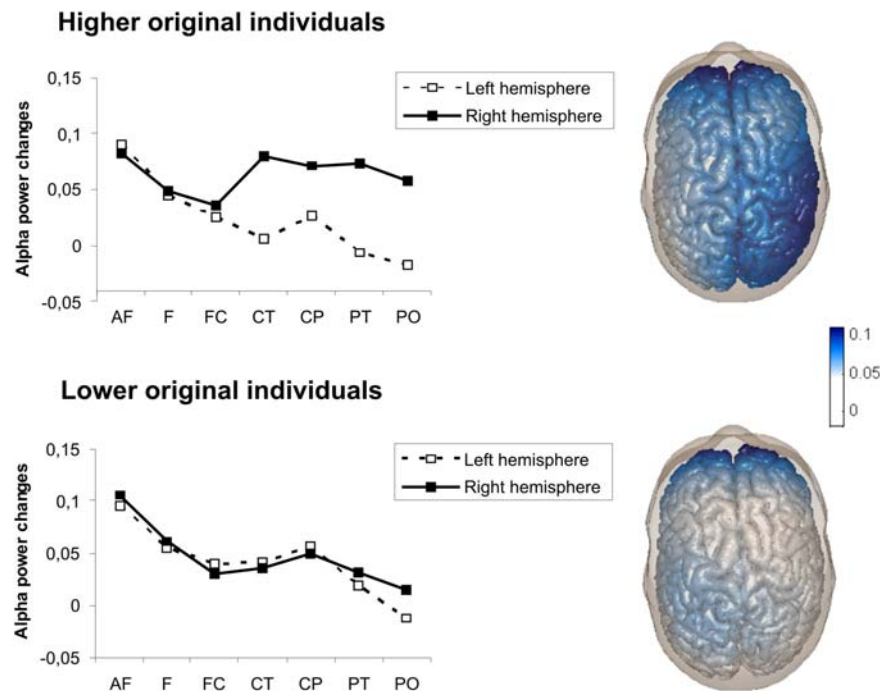


Figure 1 Task-related changes in EEG alpha power during the generation of creative uses in the Alternative Uses task separately for groups of higher versus lower originality. Blue regions indicate increases in alpha power relative to rest (fixation period). AF: anteriofrontal; F: frontal; FC: frontocentral; CT: centrotemporal; CP: centroparietal; PT: parietotemporal; PO: parietooccipital. Taken from [Fink and Benedek \(2014\)](#). *Neuroscience and Biobehavioral Reviews* 44, 111–123.

right parieto-occipital regions right before participants solved problems by insight compared to solving identical problems by analytical processing. The pre-insight alpha burst was assumed to reflect “transient sensory gating that reduces noise from distracting inputs to facilitate retrieval of the weakly and unconsciously activated solution represented in the right temporal lobe” ([Kounios and Beeman, 2014](#), p. 80). Other research looked at temporal dynamics of alpha activity during extended divergent thinking tasks. Studies reported a U-shaped pattern of alpha activity, characterized by increased alpha activity in the beginning and end of both verbal and figural divergent thinking tasks ([Schwab et al., 2014](#)). Findings replicated in other studies, which further found that functional connectivity between frontal and parietal sites increased with time, but faster so for more creative people. In the light of behavioral evidence, these time effects are thought to reflect different stages during creative idea generation, including an initial stage of recall of ideas from memory, followed by shifts towards more strategic search of novel ideas, and a final stage idea evaluation and elaboration ([Benedek and Jauk, 2018](#)). While these increasingly strategic and goal-directed processes involve higher executive control over time (as indicated by increased functional connectivity with frontal brain areas), the first and final stages may draw more strongly on memory-related demands and hence involve higher internally directed attention (as evidenced by increased alpha activity).

While the vast majority of studies focused on EEG correlates underlying divergent thinking and insight problem solving, there is a growing number of studies looking at EEG activity patterns implicated in more realistic creativity tasks. [Fink et al. \(2017\)](#), for example, investigated EEG alpha activity while participants were engaged in the generation of reappraisals to self-relevant anger-eliciting situations. Participants were required to empathize with pictorially presented anger-eliciting situations and to think of as many different ways as possible to reappraise these situations in a manner that reduces their anger. One interesting finding of that study was that generating reappraisals as compared to conventional creative idea generation (Alternative Uses Task) exhibited larger alpha power increases at frontopolar sites, which could possibly reflect increasing executive processing demands associated with the generation of effective strategies to regulate an ongoing negative emotional state.

In another study, [Fink et al. \(2018\)](#) investigated neurocognitive mechanisms associated with creative solutions in naturalistic soccer decision-making situations. During EEG assessment, hobby to amateur soccer players were presented brief video clips of real soccer scenes, and after the image was frozen, they were asked to imagine themselves as the acting player of the attacking team and to think of an original move that might lead to a goal. Performance of this task generally elicited comparatively strong alpha desynchronization at parietal and occipital sites, indicating high visuospatial processing demands during the processing of the complex soccer scenarios. In addition, more creative task performance in the soccer task was associated with stronger alpha power desynchronization over left (primary motor related) cortical sites, suggesting that individuals who generated more creative moves were more intensively engaged in processes related to motor or movement imagery.

Both the study of creativity in an affective context and the investigation of creative solutions in soccer decision-making situations constitute promising examples of studying creativity related brain activity patterns in a more naturalistic or ecologically valid way. Critically, investigations of creative processes in more naturalistic settings also facilitate testing whether the “core creativity network” identified in classic divergent thinking demands generalizes to other types of creative behavior that involve more real-life demands. In fact, both the study of creative processes in the affective and in the soccer domain yielded EEG brain activity patterns that might be relevant across different creativity domains, but they also support the idea that creativity is not a uniform process and rather involves manifold neurocognitive processes depending on the specific creativity domain (Boccia et al., 2015; Gonen-Yaacovi et al., 2013).

Other EEG frequency bands. A few studies have considered the role of other frequency bands for creative cognition. Notably, Jung-Beeman et al. (2004) observed not only an alpha burst right before subjective insights, but this was followed by increased gamma activity at right temporal brain regions, a hypothesized mechanism for binding information as it emerges into consciousness. In a similar study, moments of insight in verbal puzzles were predicted by posterior beta and anterior gamma oscillations (Sheth et al., 2009). Further evidence for the role of beta activity comes from a neurofeedback training study, which found effects on creative performance after beta neurofeedback but not after alpha neurofeedback (Agnoli et al., 2018). The generation of creative continuations to known proverbs was associated with increased upper beta and gamma activity but no changes in other frequency bands. Finally, diverging from a salient rule during a name generation task was found to be related to widespread decreases of delta activity (Boot et al., 2017). In sum, creativity has been associated to activation differences across all frequency bands, but so far, evidence is most extensive and consistent for EEG alpha activity.

Investigations of Event-Related Brain Potentials (ERP)

Event-related potentials can be observed within 1 second after stimulus onset and hence are typically used to study phenomena related to early stimulus processing. One study presented ideas that were either common, creative, or nonsensical and examined ERP responses to evaluations of their unusualness and appropriateness (Kröger et al., 2013). More unusual ideas (creative or nonsense) elicited a higher N400 (i.e., a negative peak at about 400 ms after stimulus onset), whereas later potentials between 500–900 ms tended to be sensitive to the appropriateness of ideas. Quite similarly, the N400 was most pronounced for the processing of unusual metaphors (creative or nonsense) compared to common ones (Rutter et al., 2012). Other studies found a larger (more negative) N400 when participants were presented a solution they had not found themselves. Moreover, N400 was larger when participants solved logogriphs with unrelated versus related words. These findings are consistent with the notion that N400 indexes semantic violations during processing of meaning, and thus may represent a valuable indicator of subjective novelty during idea evaluation.

The ERP approach was further used as index of cognitive control in individual differences research on creativity. For example, when presenting two brief click noises, the P50 (i.e., positive peak about 50 ms after event onset) is attenuated for the repeated, second click noise; hence, this P50 amplitude can be seen as an index of sensory gating. More effective sensory gating was associated with higher divergent thinking ability but with lower creative achievement. Similarly, a larger N200 component for detection of rare versus frequent targets was associated with higher divergent thinking ability but not with higher creative achievement. These findings provide neurophysiological evidence that divergent thinking ability, but not creative achievement, is related to higher executive control (Zabelina, 2018).

Summary

EEG has been frequently used to study oscillatory brain activity and event-related brain potentials in creative cognition. Despite the large diversity of methods and tasks, several consistent findings can be observed. Creativity has been associated with increased EEG alpha activity especially at posterior regions of the right hemisphere. This alpha synchronization likely reflects the inhibition of task-irrelevant processes, and particularly the suppression of sensory processing in order to maintain sustained internally-directed attention and shield ongoing imagination processes. Moreover, the ERP component N400 has been repeatedly associated with the processing of unusual ideas and moments of insight, suggesting that it serves as an index of subjective novelty during the evaluation stage of creative thought. Limitations of the EEG method include its low spatial resolution, which advises the use of complementary techniques (e.g. source localization) or neuroimaging methods (e.g., MRI) to address questions of topographical localization. Taken together, EEG represents a powerful method for the time-critical investigation of neurophysiological mechanisms underlying creative cognition.

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Neuroscience: Executive Functions

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Glossary

Alpha-band activity Neural activity that is often linked with relaxation, disinhibition, internally-focused attention, and some creative states.

Cognitive disinhibition The inability to ignore irrelevant information.

Default mode network The neural network comprised of midline and parietal regions that activate during task-unrelated thinking, such as mind wandering, autobiographical retrieval, and episodic future thinking.

Executive functions Control processes that regulate people's thoughts and behaviors.

Frontoparietal control network The neural network comprised of anterior parietal and lateral prefrontal regions, and is thought to play a role in deliberate attentional control.

Latent inhibition The tendency to screen from conscious awareness previously irrelevant information.

"Leaky attention" Attention that allows "irrelevant" information to be noticed.

Working memory Short-term memory that temporarily holds and manipulates information.

Introduction

There is a long-standing interest in the role of executive functions (EFs) in creativity. Historically EFs were considered to be less relevant for creativity, and were even thought to hamper creative thinking. More recent studies, however, provide empirical evidence that EFs may be linked with creativity more than previously thought. This entry reviews this line of work, and suggests that the operational definition of creativity, as well as the stage of the creative process are important when considering the role of EFs in creativity.

EFs are control processes that regulate one's thoughts and behaviors. A number of EF models have been proposed, including the self-regulatory model (Barkley, 2012), problem-solving model (Zelazo et al., 1997), Lezak's conceptual model (Lezak, 1995), Miller and Cohen's model (Miller and Cohen, 2001), Miyake and Friedman's model (Miyake et al., 2000), and Banich's "cascade of control" model (Banich, 2009). Prefrontal lobe regions have been reported to be implicated in regulating EFs, including the dorso-lateral prefrontal cortex (DLPFC), anterior cingulate cortex (ACC), and orbitofrontal cortex, although other evidence suggests the involvement of additional brain regions as well.

Evidence for Low Executive Functions in Creativity

One line of work suggests that creativity benefits primarily from cognitive disinhibition. Cognitive disinhibition may allow more stimuli into people's conscious awareness, and allow them to notice information that other people may dismiss as irrelevant, enhancing the chances for a creative idea. Indeed, earlier studies reported that creativity is linked with diffused or "leaky" attention. For example, in a dichotic listening task more creative people are more likely to experience intrusion errors from the unattended ear. Similarly, more creative people are more likely to make use of "irrelevant" stimuli playing in the background while performing a memorization task. More creative people are also more likely to have low latent inhibition—i.e., the propensity to screen from conscious awareness previously irrelevant stimuli.

More recent work supports the potential role of lower EFs, such as “leaky” attention, in creativity. In one study, participants were asked to identify a target letter (S or H) within hierarchically constructed stimuli (i.e., large letters made up of small letters; Zabelina et al., 2016). Critically, 50% of the letters were congruent, where the large and the smaller letters were the same (e.g., large S made up of smaller ss), and 50% were incongruent, where the large and the small letters were different (e.g., large S made up of small hs). Thus, if someone’s attention is more “leaky,” they would respond quicker on the congruent trials, but slower on the incongruent trials. The congruency effect, i.e., how much faster people responded on the congruent, compared to the incongruent trials, was a measure of the congruency effect. Indeed, higher creativity was significantly correlated with a larger congruency effect, suggesting that more creative people may have “leaky” attention (Zabelina et al., 2016).

Neurophysiological studies provide confirming evidence for the link between creativity and cognitive disinhibition. Both earlier and some recent studies (for review, Benedek, 2018; Stevens and Zabelina, 2019) find that alpha-band activity—activity that is often linked with relaxation and disinhibition, is associated with creative states. However, other recent work questioned the role of alpha-band activity in creative thinking, proposing that alpha power reflects internally focused attention rather than disinhibition per se (Benedek et al., 2014).

Cognitive disinhibition has been discussed as the common link between the reported associations between creativity and some forms of dimensional psychopathology traits, namely psychoticism and hypomania (Zabelina et al., 2014), and the personality trait of openness to experience (Silvia et al., 2009), although the “mad -genius” controversy remains contentious.

Evidence for High Executive Functions in Creativity

Opposing evidence comes from studies that suggest that creative thinking relies largely on good executive functions, and may not be so different from intelligence. A recent study has shown that divergent thinking is linked with the ability to update concepts in working memory (Updating), while people who work in the artistic domains show better mental set shifting abilities, as well as successful regulation of their thoughts and behaviors (Zabelina et al., 2019). More creative people are also likely to inhibit more prepotent responses and show better working memory abilities. Finally, brain regions that are involved in cognitive control, such as inferior frontal gyrus (IFG) and inferior parietal cortex have repeatedly been shown to activate on tasks requiring creative thinking.

A Complex Interplay

Recent evidence points to a more complex interplay between controlled and uncontrolled processes in creative cognition. Such interplay is evident at the person, process, and the brain levels, and may also depend on the operational definition of creativity.

Individual Level

It is possible that at the individual level, both controlled and uncontrolled processes are involved, but are evident at different levels of cognition. Namely, at the bottom-up level, more creative people may be likely to experience cognitive disinhibition or “leaky” attention, as has been suggested by a number of investigations. At the top-down level, creative people may excel at controlled processes as well, as has been suggested by others. Indeed, creative acts, such as writing a novel or designing a complex computer code often require controlled processes like focused attention. Future work will need to investigate executive functions at the bottom-up versus top-down levels in creative individuals.

Process Level

The role of executive functions in creativity may also differ at the process level. Since the time of Wallas (1926), the creative activity has been discussed as a multi-stage process, where the primary stages include preparation, incubation, illumination, and verification. Thus, lower executive functions may benefit some stages of the creative process, such as incubation, while good executive functions may benefit other stages, such as preparation or verification. Indeed, during the preparation stage, persistence and focus may serve someone who is looking to learn what is already known in the field and what issues can be addressed further. Indeed, deep thinking has been shown to reduce shifting flexibility and increase task shielding. During incubation, however, it may be best to release cognitive control to let the ideas flow in.

Brain Level

Neuroimaging evidence provides strong support for a complex interplay between controlled and uncontrolled processes in creative thinking. This evidence comes from a number of recent functional magnetic resonance imaging (fMRI) studies examining dynamic brain network interactions, particularly between the default-mode (DM), the frontoparietal control (FPC), and the salience networks. The DM network is comprised of midline and parietal regions that activate during task-unrelated thinking, such as mind wandering, autobiographical retrieval and episodic future thinking. The FPC network is comprised of anterior parietal and

lateral prefrontal regions, and is thought to play a role in deliberate attentional control. Insula, the primary hub of the salience network, is involved in switching between the DM and the FPC networks.

Creativity has been repeatedly shown to be linked with dynamic interactions between the DM and the FPC networks both at the process level (during tasks requiring creative thinking, and during the certain stages of the creative process), and at the individual level (in people who are thought to be more creative). Specifically, on a divergent thinking task, on which people are asked to generate a number of creative uses for a common object, such as a brick, early stages of the creative process show co-activation of the DM and the salience networks, while later stages exhibit co-activation of the DM and the FPC networks (Beaty et al., 2014). In other studies, idea elaboration (Ellamil et al., 2012) and poetry evaluation (Liu et al., 2015) were associated with increased co-activation between the DM and the FPC networks as well. Christoff and colleagues proposed a dynamic framework model where creativity is thought to involve dynamic and rapid switching between the controlled and uncontrolled processes (Christoff et al., 2016). At the individual level, people who perform better on divergent thinking tasks similarly show coupling between DM and the FPC networks at rest (Beaty et al., 2014).

Operational Definition of Creativity

The degree to which executive functions play a role in creative thinking may depend on the operational definition of creativity. Currently divergent thinking tests are the most widely used assessments of creative cognition. Recently, other measures, such as semantic distance (the degree to which two terms are related), have been employed as a way to examine creative thinking. In line with the results on divergent thinking tests, increased semantic distance has been shown to be linked with the dynamic interaction between the DM and the FPC networks (Green et al., 2015). Other work has confirmed that both DM and the FPC networks are involved in creation of metaphors, and detection and appreciation of humor, both of which have been used to operationalize creativity.

Conclusion

Earlier discussions of the executive functions and creativity have primarily focused on the importance of uncontrolled processes in creativity. Later models discussed the involvement of good executive functions, such as focused attention and fluid intelligence in creative thinking. Mounting recent evidence, however, points to a more complex interaction between controlled and uncontrolled processes in creativity. Such evidence comes from work on individual differences in creativity, the examination of the various stages of the creative process, neuroimaging studies of the large-scale brain network interactions, and on the importance of considering operational definitions when examining the construct of creativity.

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Neuroscience: Music and the Brain

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Glossary

Auditory Network This set of brain regions consists simply of primary auditory cortex (on the upper plane of the superior temporal gyrus) and neighboring, secondary auditory regions along the posterior and anterior superior temporal gyrus (This network is colored yellow in Fig. 1).

Default-Mode Network A set of brain regions (particularly medial prefrontal cortex and posterior cingulate cortex) that show greater activity during diffuse states of consciousness (such as daydreaming), internal direction of the attention, and spontaneous mentation (This network is colored red in Fig. 1).

Evaluative Phase This phase is an integral part of the creative process, which, however, must come after ideas have been generated and/or transformed in the above phases. Composers (and other creators) often seek to suspend evaluation until well after sufficient material has been generated, as evaluative processes can seem to suppress generative processes. Particularly in the case of artistic creativity (including musical creativity), this phase is associated with activity in the salience network.

Executive Network A set of brain regions (particularly dorsolateral prefrontal cortex and inferior parietal cortex) that show greater activity during tasks that require complex cognitive (top-down) control and active maintenance and/or manipulation of working memory contents (This network is colored green in Fig. 1).

Generative Phase This phase is predominantly passive and dreamlike, during which creative thoughts appear to generate themselves (bottom-up). The Generative phase has been predominantly associated with activity in the default-mode network, particularly (in the case of musical creativity) in cooperation with the motor planning network.

Motor Planning Network Integral to the planning of complex motor acts such as those characteristic of speech and tool use, this set of regions (particularly premotor cortex and the supplementary and pre-supplementary motor areas) is equally integral to musical capacities, both perceptual and productive, and particularly those that are most “creative.” (This network is colored blue in Fig. 1.)

Note-and-duration sequences While the term “musical creativity” can be interpreted extremely broadly, the restricted definition used in this article is the generation of novel patterns of notes and durations—i.e., patterns (or melodies/sequences) that are not already familiar to the composer/improviser.

Phases of the Compositional Process As creativity is not a single cognitive act but a complex set of interacting processes, it is valuable to subdivide the larger construct into phases, such as the generative, transformative, and evaluative phases.

Salience Network A set of brain regions (particularly the insula and anterior cingulate cortex) that show greater activity when the attention is captured (bottom-up) by stimuli reflexively deemed to be significant. The amygdala and other subcortical structures are often included in this network of regions (This network is colored purple in Fig. 1).

Sequence Music differs from the plastic arts (e.g., painting and drawing) in that musical works do not exist “all at once,” but necessarily unfold over time. For the brain to represent a musical melody (or other short passage), it therefore must build a mental representation for a string of events that connect to one another, at both the short-range (events immediately preceding and following) and the long range (e.g., noting a melody’s recurrence later in a work, and possibly the differences in the later iteration relative to the initial presentation). Across animal studies, such strings of complex motor and/or perceptual events are referred to as “sequences.”

Transformative Phase This phase is active and controlled, typically guided by internalized goals and the conscientious application of the recombinative “rules” of traditional composition and improvisation training. This phase has been predominantly associated with executive network activity, particularly (in the case of musical creativity) in cooperation with the motor planning network.

Introduction

Of all the creative arts, music is one of the most iconic, with images of Beethoven, Bach, and Mozart looming large—often quite literally—in the pantheon of western musical culture. Add to this the cults of personality that have arisen around equally influential musical creators such as Louis Armstrong, Miles Davis, Elvis Presley, the Beatles, Madonna, and Beyoncé, and the conclusion is inevitable: culture is massively influenced by the creative art form referred to as “music.”

Defining Musical Creativity: The Generation of Novel Note-and-Duration-Sequences

What, then, is “music,” and what specifically does it mean to be “creative” in music? The question is obviously a vast one and can only be addressed cursorily here. At the broadest scale, “music” could be defined as any intentional manipulation of sound patterns, typically for the appreciation of an audience. To be “creative” in music, therefore, could be defined as to manipulate sounds in ways that are novel, and thus function to influence the relationship between creator and audience. As such, creativity in music can be understood to encompass a large range of behaviors, from the obvious acts of composing and improvising to the more subtle but still “pattern-manipulative” acts of interpreting classical works, arranging and reharmonizing jazz standards, and even—as David Rosenboom has convincingly argued—simply listening to music actively and imaginatively. For simplicity’s sake, the present article restricts this broad focus by defining musical creativity as “the generation of novel note-and-duration sequences.” In this sense, the focus is predominantly upon the acts of composition and improvisation. However, it should be noted that this definition does not apply solely to professionals and students in these fields, but rather includes virtually anyone who invents a melody—even a bird or whale—as being “musically creative.”

Musical Creativity Versus Other Forms of Creativity

While creativity shares features across fields, there are aspects of musical creativity that are relatively unique to it.

1. *Speed.* The act of creating music, particularly in the case of improvisation, is often extremely rapid. Such “real-time composition” (as improvisation is often called) requires not only a precise command of fine-grain musculature (e.g., the fingers, mouth, and/or larynx), but also the capacity to execute those commands at sub-second levels temporal precision.
2. *Temporal extension.* Like film, dance, and storytelling, but unlike painting, sculpture, and architecture, music is a temporal art, requiring time to unfold. Thus for both the composer/improviser and the listener, the working memory apparatus plays a critical role in assembling a mental representation of the whole of the musical work—since the whole does not really “exist” at any single point in time except in the form of memory (ignoring “prosthetic” memory representations such as written scores and audio recordings).
3. *Symbolic structure.* Just as spoken words and sentences are constructed from a limited set of phonemes, so too are musical melodies constructed from a limited set of notes and durations. In this sense they are both “symbolic,” i.e., composed of “symbols” (or “elements”) which in themselves have no meaning. However, an important distinction between speech and music is that phonemes, when combined in specific ways, do produce recognizable “words” which can refer to events and objects outside of the language system itself, and thereby take on meaning. In contrast, recombinations of musical elements only rarely refer to anything outside of the realm of music. The fact that these different combinations of musical elements can still feel “meaningful” to a listener, therefore, is a peculiarity of the art of music that is worthy of paying special attention to.

Phases of the Music-Creative Process

Creativity in music, as in other fields, is not a single cognitive act but rather a set of processes. Based upon a survey of writings from composers from as far back as the classical era (as synthesized by writers such as Ian Bent), the compositional process can be subdivided into the following three phases.

1. *The Generative Phase.* Many composers (and improvisers) state that their best ideas come to them unbidden, particularly when they are in a dream-like or semi-conscious state (e.g., Brahms, Mozart, Reicha). This phase is therefore largely a passive one, although composers may actively seek to enter such states, and they often develop elaborate rituals for capturing with high fidelity (whether in written or audio format) the fruits of such dreamy labors. In the words of Brahms, for instance: “[Inspiration] cannot be [achieved] merely by will power working through the conscious mind ... I have to be in a semi-trance condition to get

such results." When inspired, however, "I immediately feel vibrations that thrill my whole being ... Straightaway the ideas flow in upon me ... and ... are clothed in the right forms, harmonies, and orchestration. Measure by measure, the finished product is revealed to me when I am in those rare, inspired moods ..." (Abell, 1955, p. 5).

2. *The Transformative Phase.* While composers tend to consider the generative phase to be a critical one, it is rare for them to suggest, as Brahms seems to do above, that the entirety of a musical work can come to them fully formed. Brahms in fact clarifies later in the interview that "of course, a composer must have mastered the technique of composition, form, theory, harmony, counterpoint, [and] instrumentation" for ideas to be "revealed" in such a way, and that "my compositions are not the fruits of inspiration alone, but also of severe, laborious and painstaking toil" (Abell, 1955, pp. 5–6, 59). For Brahms and many other composers, the generative phase is necessarily succeeded by an active process of consciously and conscientiously working with one's materials—manipulating them according to the rules of counterpoint, for instance—a process which is typically treated as the bulk of the "work" done by the composer.
3. *The Evaluative Phase.* Finally, while both the generative and transformative phases can be seen predominantly to increase one's store of material, clearly not all generated materials can be used—they must be evaluated. In music as in other fields, evaluative processes are often experienced as discordant or even competitive with generative processes, and thus relegating them to a distinct phase is not an infrequent recommendation.

Though presented as successive here, these behaviors may not occur linearly in real-world creative contexts, but rather may alternate rapidly according to task demands. Particularly for the case of improvisation, as compared with written composition, generative behaviors may be seen as more typical of live performance, whereas transformative behaviors may be more typical of how musicians prepare for performance—and thus may precede rather than succeed the former.

Musical Creativity from the Neuroscientific Perspective

Given the complexity of the set of behaviors falling under the construct of "musical creativity," it is not immediately obvious how this construct could be rigorously investigated from the neuroscientific perspective. Admittedly, that which is currently known about the neuroscience of musical creativity is only a tiny fraction of what one might ultimately wish to know to generate a proper "theory" of the creative musical brain. Nevertheless, the neuroscientific work that has been done on the subject, particularly over the last decade, has yielded insights that could not have been imagined through the use of humanistic (insight-based) techniques alone, and therefore offers a unique contribution to the understanding of musical creativity.

Historical Review

The pioneering study in the field was conducted in 2008 by Charles Limb and Allen Braun, who recruited six professional jazz pianists to improvise while having their brains "scanned" with functional magnetic resonance imaging (fMRI). Such a procedure tracks the flow of deoxygenated blood in the brain in real time, giving a sense of which brain regions have used more oxygen during a task, and hence which are likely to have been "active" during the task. The authors found that, when improvising, compared with playing a memorized melody, the musicians showed greater activity not only in auditory and motor-planning regions (as might be expected), but also in a set of regions implicated in internally-directed attention called the "default-mode network." Additionally, the authors reported reduced activity in "emotional" or "limbic" regions, and in a set of regions that is often found to act in opposition to default-mode regions, referred to as the "executive network." A subsequent investigation from Dr. Braun's laboratory (led by Siyuan Liu) reported comparable findings for improvised rap performance, as have a number of studies from other laboratories since that time. Such initial findings therefore seemed to support the notion that seasoned improvisers might go into a "defocused" cognitive mode when improvising, resembling the "dreamlike" or "semi-conscious" generative state described by composers such as Brahms and Mozart.

However, several other studies reported the almost precisely opposite finding—that default-mode activity reduces during improvisation (rather than increases), while executive mode activity increases. This "paradox," to quote the author, was elegantly resolved in a pair of studies by Ana Luísa Pinho and colleagues published in 2014 and 2015, which paid particular attention to the degree of improvisation-specific musical experience participants had (compared to classical music experience), as well as to the specifics of the improvisatory task assigned (contrasting a "pitch-set" task, which was assumed to be more cognitively demanding and restrictive, with an "emotional" task which was assumed to be less restrictive). Indeed, it was found that default-mode and executive network activity varied as a function of both experience and task: subjects with more improvisation-specific experience showed greater recruitment of the default-mode network and less executive activity than those with less experience; and the less restrictive "emotional" task similarly recruited more default-mode activity and less executive control than the more restrictive, cognitively demanding "pitch set" task. In other words, when tasks were "easier"—taking into account the participant's degree of improvisation-specific training, the restrictiveness of the task demands, and the degrees of freedom inherent in the set of elements available for recombination (e.g., number of keys)—default-mode activity tended to be higher and executive activity lower; when tasks are "harder," the opposite pattern was observed.

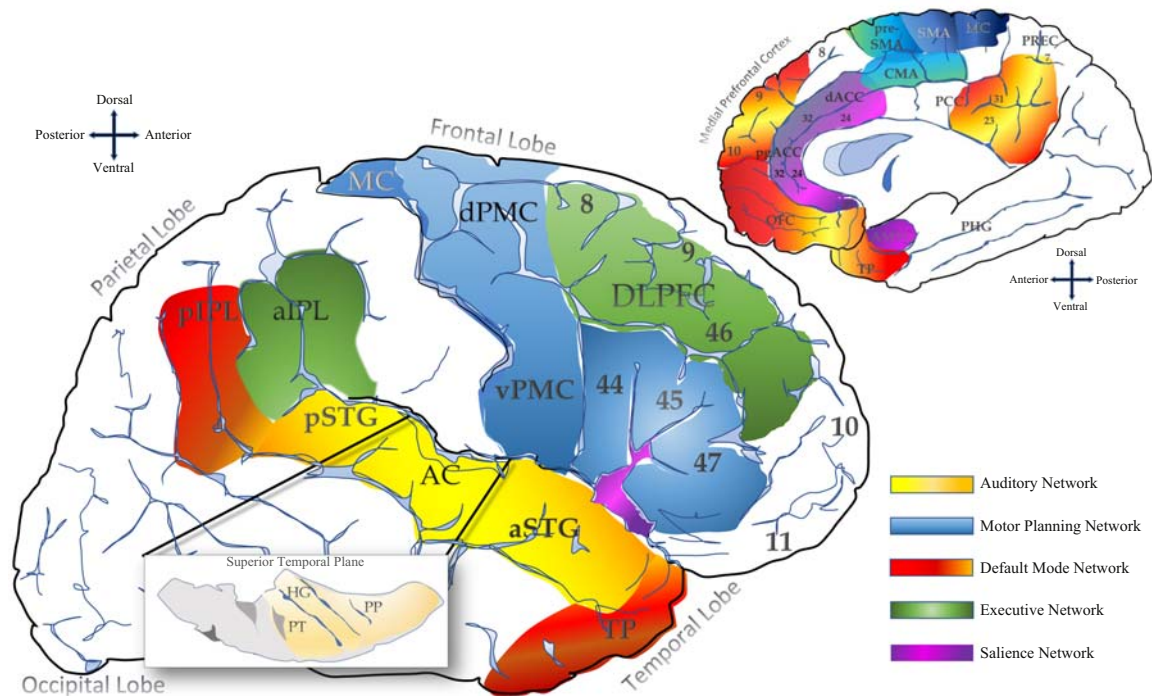


Figure 1 Regions and networks of the human brain implicated in musical creativity. *Bottom left*: lateral view of right hemisphere; *top right*: medial view of right hemisphere. Networks are color coded: yellow, auditory; red, default; green, executive; blue, motor; purple, salience. Numbers refer to Brodmann areas. Abbreviations: AC, auditory cortex; aIPL, anterior inferior parietal lobule; AMYG, amygdala; aSTG, anterior superior temporal gyrus; CMA, cingulate motor area; dACC, dorsal anterior cingulate cortex; dPMC, dorsal premotor cortex; HG, Heschl's gyrus; MC, primary motor cortex; OFC, orbitofrontal cortex; PCC, posterior cingulate cortex; pgACC, pregenual anterior cingulate gyrus; PHG, parahippocampal gyrus; pIPL, posterior inferior parietal lobule; PP, planum polare; PREC, precuneus; pre-SMA, pre-supplementary motor area; pSTG, posterior superior temporal gyrus; PT, planum temporale; SMA, supplementary motor area; TP, temporal pole; vPMC, ventral premotor cortex.

Brain Networks and Their Interactions

The brain is obviously massively complex in both its structure and function. Structurally the brain is not homogeneous, like the liver or the blood, but consists of a vast diversity of neuron types which form an overwhelming number of individual nuclei which process information in unique ways. This structural complexity at the regional level is compounded by the large-scale folding patterns of the neocortex. While each hemisphere of the neocortex is actually a single continuous “sheet” of (several layers of) neurons, this sheet folds in itself in order to fit within the skull, and as a result forms the four classical “lobes”—frontal, occipital, parietal, and temporal (see Fig. 1).

Traditionally, scientists have sought to understand brain function in coordination with this large-scale folding pattern (and the smaller scale patterns within each lobe, such as the division of the temporal lobe into three gyri, one located superiorly, one inferiorly, and one in between). Auditory regions, for instance, are located on the superior (upper) plane of the superior temporal gyrus (colored yellow in Fig. 1), while motor regions are located along the posterior edge of the frontal lobe (colored blue in Fig. 1).

While these observations undoubtedly hold true, it has become increasingly common for scientists to investigate how regions cooperate with one another—i.e., form networks—when engaged in certain tasks (or even when “at rest”—i.e., without an explicit task demand from the experimenter). This focus on network activity has proven particularly important for understanding complex mental behaviors such as “being musically creative.” While specific cortical regions can be identified for sound perception (such as those on the superior temporal plane), or sound production (such as the motor and premotor regions that control the voice and hands.), no single cortical region has been—or is ever likely to be—identified as “the” creative part of the musical brain.

Auditory-Motor Interactions

Consistent with this view, an examination of the findings of previous studies on the neuroscience of musical creativity reveals no single “auditory region” (on the superior temporal plane) that is consistently implicated in creative musical behavior. Similarly, very few studies implicate primary motor cortex in musical creativity. What this suggests is that being musically creative is neither simply auditory nor simply motoric, but rather something having to do with their interaction with one another.

This conclusion is supported by two types of evidence. First, while the Limb and Braun study described above analyzed the degree to which deoxygenated blood flow increased or decreased in individual brain regions, recent studies have additionally examined the “functional connectivity” observed between regions, i.e., whether any changes in blood flow in one region correlate with changes in other regions. Such functional connectivity analyses frequently report enhanced connectivity between auditory and motor regions during music-creative states—as well as altered degrees of connectivity with hub regions of the default-mode, executive, and salience networks.

Thus, connectivity seems to be altered between auditory and “motor” regions during music-creative states. However, the “motor” regions most consistently implicated in music-creativity findings, as mentioned above, typically do not include primary motor cortex—i.e., the portion of neocortex which, when stimulated, elicits movement directly. Rather it is the higher-level “motor planning” regions which are most frequently implicated in such studies. These regions are referred to as “motor” regions, but more accurately they are the critical means of interface whereby the remaining regions of the neocortex access the motor system. Typically these regions contain “mirror neurons,” which respond both during the perception and the production of a motor behavior. Such mirroring was first observed with the visual system but has been convincingly demonstrated for the auditory system as well. When trained musicians hear musical passages, for instance, activity in premotor cortex resembles that which would be required to play the passage; and reciprocally, when trained pianists depress keys on a silent keyboard, auditory regions (secondary rather than primary) show activity corresponding to the sounds that would actually be heard were the keyboard not silent. The “motor planning” regions consistently implicated in musical creativity studies, therefore, can fairly justifiably be reconceptualized as “auditory-motor integration” regions. A short summary of the roles played by these regions is offered here.

1. *Premotor cortex.* While primary motor cortex (at the posterior end of the frontal lobe) controls the finest details of motor coordination, premotor cortex (just anterior to it) coordinates higher-level complexes of motor commands (e.g., the movement of the whole arm to play a note, rather than just the individual fingers). Even further anterior to premotor cortex is a second strip of cortex sometimes referred to as “pre-premotor cortex,” which may coordinate even more abstract complexes of commands (e.g., coordinating the trunk movements necessary to promote the arm movements that allow the fingers to depress certain keys). Premotor cortex may be particularly important for coordinating body movement with the brain’s visual representation of the external world (e.g., situating one’s hands on the keyboard relative to middle C).
2. *Supplementary, pre-supplementary, and cingulate motor areas.* While lateral cortical regions (such as premotor cortex) tend to be guided by external demands (e.g., following a conductor), medial regions tend to be guided more by internal forces. Thus the supplementary, pre-supplementary, and cingulate motor areas show the greatest involvement when a movement is self-initiated and/or guided by emotional state. The former two regions (supplementary and pre-supplementary motor cortex) are also implicated in both the timing of movements and the grouping together of multiple individual events into “chunks” (the rough equivalent of motives in music or words in speech).
3. *Inferior frontal gyrus.* Just anterior to premotor cortex in the inferior part of the frontal lobe is a region which, in the left hemisphere, is called Broca’s area, but more generally can be referred to as the inferior frontal gyrus (this region is labeled in Fig. 1 according to Brodmann’s classification scheme as areas 44, 45, and 47). Broca’s area is critical in speech, particularly in concatenating “chunks of chunks,” i.e., concatenating words into phrases, phrases into sentences, and perhaps sentences into larger discourse groupings (such as paragraphs). In music, a parallel function of Broca’s area (in the right hemisphere) appears to be allowing improvisers to string short motives together into larger musical phrases, promoting a kind of “grammar” of recombination—which can be both predictable (following basic “rules”) and yet novel (producing never-before-heard combinations). This is an idea which is likely critical to understanding the brain basis of musical creativity and will be returned to below.
4. *Putamen.* All cortical regions, but especially frontal regions, project to an underlying nucleus called the striatum (part of the basal ganglia), which aids both in the acquisition of new motor patterns/sequences (during learning) and in the selection of previously acquired sequences (during performance). Of the striatum’s three subregions (caudate, putamen, and nucleus accumbens), the putamen region is the most consistently implicated in the acquisition and execution of motor patterns, particularly for beat-based metrical motor coordination and perception (as opposed to raw interval timing that is not metrically/hierarchically structured).
5. *Cerebellum.* While the putamen is particularly critical for tapping to the beat in metrical sequences—with beats occurring at rates of between about 1 and three taps per second—the cerebellum appears to be mostly involved at a finer-grained level of temporal coordination—on the order of milliseconds rather than seconds. The cerebellum is also likely involved in coordinating the inputs across senses (as they relate to auditory-guided motor performance), including not only motor and auditory senses but also vision and somatosensation. A main function of the cerebellum may be to receive “efference copies” of motor commands that are being sent, and to therefore predict the sensory consequences of such commands, sending “error messages” back to the neocortex only to the extent that the sensory expectancies differed from the actual sensory signal received.

Other Networks

While the auditory and motor-planning networks appear to form the foundation of basic music-cognitive functioning, on their own they are likely insufficient to account for creative music cognition. At least three additional networks appear to play key roles in differentiating what could be called “normal” music-cognitive behavior from “creative” behavior.

1. *The default-mode network.* As noted above, default-mode regions are the most frequently implicated in studies of creativity, including musical creativity. Consisting predominantly of medial (rather than lateral) cortical areas—such as medial prefrontal cortex, posterior cingulate cortex, precuneus, and temporal pole (colored red in Fig. 1)—these regions have privileged access to the body's current feeling state and show enhanced activity during diffuse modes of consciousness (including both daydreaming and normal nighttime dreaming). Default-mode activity tends to be greater in participants scoring higher on creativity tasks, and in individual participants engaging in more vs. less creative tasks. This is particularly the case for tasks centered upon idea-generation, i.e., the generative phase of the creative process.
2. *The executive network.* Historically, the executive network—consisting primarily of dorsolateral prefrontal cortex and posterior parietal cortex (colored green in Fig. 1)—was characterized as working in opposition to the default-mode network, with executive regions more activate for tasks requiring focused, external direction of the attention (in contrast to default-mode regions, which were more active during unfocused and/or internally directed attentional tasks). More recently, however, this simple oppositional perspective has been revised. In part through developing new, more sensitive analytical techniques, Roger Beaty and colleagues in particular have promoted a more nuanced understanding of the ways in which the executive and default-mode networks interact during creative tasks—demonstrating that these networks may in fact be more cooperative and interconnected with one another in creative individuals and/or during creative tasks, rather than less cooperative/interconnected. The executive network is also frequently found to be more connected with motor planning regions during improvisation, suggesting a degree of top-down control over performed patterns of musical notes, and thus potentially corresponding to the transformative phase of the creative process as described above.
3. *The salience network.* A third network, referred to as the salience network, can be conceptualized as a link between the cognitive systems of the brain/mind and its emotion systems. When a new or surprising event (an event deemed “salient”) is perceived, activity in the salience network often has the capacity to override ongoing activity in executive, default, and other networks, thus effectuating the “capture” of the attention by the novel stimulus. Importantly, while salient stimuli are typically portrayed as coming from outside (a ringing phone, an evocative odor), they may come from within as well, as in a self-generated thought or melody. In the generative phase, therefore, this network may be important in recognizing that an internally-generated idea has presented itself. However, because of this network's basis in brain regions that use information about the body's current feeling state to assign “value” to encountered objects and events, the salience network (consisting predominantly of the anterior insula, anterior cingulate cortex, and amygdala; colored purple in Fig. 1), while potentially playing a subsidiary role in the generative phase, is likely a key player in the evaluative phase—particularly for artistic (rather than scientific) forms of creativity.

Generating a Novel Melody: A Speculative Proposal

While the findings summarized above offer valuable insights into the higher-level workings of the creative musical mind, they nevertheless leave unaddressed some of the more basic questions one might wish to know about musical creativity, such as “how does a brain generate a new melody,” i.e., a novel “note-and-duration sequence”? While seemingly simple, this question is still deceptively complex to be addressed, and arguably has not been satisfactorily answered by the existing neuroscientific evidence. However, by subdividing this larger question into sub-questions that have more direct answers, it is possible to speculate as to what might be going on in a human brain, mechanistically speaking, when a novel melody is created.

The following sub-questions will be addressed in turn:

1. How does the brain represent a familiar melody?
2. How does the brain read from this internal representation to perform, i.e., “re-create,” the original melody (whether aloud or in the imagination)?
3. What might be different in a brain (or brain state) that would lead to the creation of a new melody rather than the re-creation of a familiar melody?

Representing a Familiar Melody

In a thought-provoking essay on the representation of melody in the human brain, titled *Is There a Tape Recorder in Your Head?*, neuroscientist Josef Rauschecker pointed out that auditory cortices demonstrate excellent sensitivity to the spectral aspects of sound, such as pitch and timbre. However they are less capable of representing, at least on their own, the temporal properties of a sound stream beyond the length of a few notes—the equivalent in speech of single words and possibly short phrases. Just as frontal regions are necessary in speech for stringing together words and phrases into complete sentences, so too in music it appears that frontal regions may be necessary for stringing individual notes and short motifs together into even the shortest and simplest of melodies. Melodic representations, in other words—even those that have only been perceived but never performed—are likely not purely “auditory,” nor have a locus solely in the temporal lobes, but rather are in essence auditory-motoric, with a representation distributed across both temporal and frontal cortex.

The frontal regions implicated in stringing together motives to create a melodic representation are, as might be expected, the motor planning regions introduced above: premotor cortex, the supplementary and pre-supplementary motor areas, and Broca's area (in both hemispheres), along with subcortical regions such as the putamen and possibly the cerebellum. It is worth recalling that the representation afforded by this collection of regions may be highly multifaceted and even multisensory: while auditory regions may specialize in representing a melody's sonic aspects, premotor cortex may specialize in representing the spatial aspects of the motor behaviors required to produce it, and the supplementary and pre-supplementary motor areas may specialize in representing its temporal properties (such as its alignment with a mental "grid" of hierarchical rhythmical proportions, i.e., its metrical interpretation).

The pre-supplementary area has also been implicated in stringing together individual items—such as basic motor behaviors, potentially equivalent to individual key presses on a musical instrument—into "chunks," as well as cooperating with Broca's area and the putamen to string together the "chunks of chunks" that could conceivably amount to the representation of entire melodies, and possibly even larger sections of works (e.g., verses and choruses in popular and folk songs). The representation of melody in the brain is therefore likely highly distributed (not localized to a single region) as well as dynamically "assembled" in real-time (rather than being represented statically as a whole at any one point in time, except possibly in the case of highly familiar and simple melodies, such as "Happy Birthday").

Imagining a Familiar Melody

Now that a rough account of the representation of melody in the brain has been established, the two remaining questions are: how is such a representation "read from" when this familiar melody is "performed" (whether aloud or only in the mind); and what might differ in the case of performing of a melody (again either aloud or mentally) that does not already exist as a memory trace in the brain, but is created anew as an unforged path through melodic space?

In answer to the first question, the case of imagining (rather than performing aloud) the sound of a familiar melody will be considered, since this is a behavior that, while not specific to musical composition, is critical to it. As might be expected based on the previous discussion, to "read from" or "activate" a memory representation for a melody, both motor-planning and auditory structures are critical. Notably, this typically excludes primary motor and auditory structures, and instead relies upon secondary and associative auditory and motor structures.

When such imagery is active—i.e., when singing through a melody in one's head is intended rather than accidental—it seems likely that executive regions would be implicated (a supposition supported by the fair but not extensive number of extant studies on the subject). An interesting comparison can be made with melodic imagery that is not active but passive, i.e., unintended—such as when one has "a tune stuck in one's head" (often called an "earworm"), or alternatively when a composer has a novel melody spontaneously come to her, either during the normal waking state, in a dream, or in some hybrid state in between. In such cases, it may be the default-mode network (rather than the executive network) that is more active in driving the motor-planning and/or auditory networks. The evidence on this point is meager, but findings by Nicolas Farrugia (on earworms), Sibylle Herholz (on active imagery), and Sukhbinder Kumar (on musical hallucinations) offer at least partial support for the model offered here.

Imagining a New (Unfamiliar) Melody

Finally, having established a prospective account of how a brain mentally "performs" a melody from a pre-existing representation of that melody, it may now be inquired as to what might be different in a brain that, rather than re-creating a familiar melody from a pre-existing representation, instead invents a new one. It may seem incredible that the brains of composers and improvisers can readily do this, but if the parallel case of speech is once again considered, it will be recognized that all normal speakers of a language "improvise" and "compose" novel utterances virtually all the time—much more readily, in fact, than they recite memorized utterances verbatim (such as citing Bible verses). While any newly improvised sentence in an everyday conversation is of course not "entirely new," but rather recombines familiar elements (words, phrases, idioms, etc.), the same is the case with music improvisation and composition. It should, in theory, be no more difficult to account for how novel musical utterances are constructed than to do the same for novel spoken utterances. Such a comparison could be a potentially fruitful avenue for future investigation.

A second point of comparison can also be offered which ties together many of the themes developed in this entry thus far: the comparison between the creative state and the dream state. As mentioned above, one of the most consistent statements of composers made about their creative processes is the foundational importance of a "dreamlike" generative state, in which "the best" ideas often come to them unbidden, and in the case of some composers (such as Mozart and Brahms) may even lead to the generation of an entire work, as long as this "semi-conscious," dreamlike state of creation is not interrupted. Such descriptions of this generative compositional state more than superficially resemble the dream state: it is not simply that the feeling of this cognitive state is "semi-conscious" or "dreamlike," but much more significantly that it is typified by the (seemingly) passive reception of mental contents—contents which some part of the composer/dreamer's brain must of course be generating, but which seem to come from nowhere (or from a supernatural being, such as a god or devil). Dreams can on occasion be static and/or boring, but they are often interesting, even bizarre—and emotionally potent as well. When composers state that their "best ideas" come from such dreamlike states—or in Brahms' words, "the themes that will endure in my compositions all come to me in this way" (Abell 1955, 6)—they seem to be saying not simply that ideas come easily in such states, but that the ideas generated in such states

are actually better than those generated during normal waking consciousness—or what might be called “transformative” consciousness, the cognitive state characterized by the transformative phase.

As stated previously, the generative phase is characterized most consistently by default-mode activity, while the transformative phase likely aligns mostly with executive network activity. It may be no coincidence, therefore, that the dream state is characterized by enhanced default-mode activity, and reduced executive-network activity. The neurochemistry of the dreaming brain is better understood than that of the creative (musical) brain, and therefore, it may also be productive to investigate whether and to what extent the neurochemical signatures of the dream state—high acetylcholine levels and low serotonin and norepinephrine levels—also typify and/or influence creative (musical) states.

However, it should be noted that to be creative is not simply to be asleep! Composers and other artists have developed elaborate rituals for maintaining partial consciousness during their dream-like, content-generative reveries, and in seemingly all cases a kind of hybrid state between being asleep and being awake is described. Semi-conscious states may be multiple and varied, as indicated, for instance, by comparing brain activity in different types of meditative state (as described in a recent review by Rozalyn Simon and Maria Engström). In some cases default activity is increased, while in others it is decreased; similar observations would likely be found for executive network activity, and possibly salience network activity as well. There may be any number of “semi-conscious” states that practitioners of improvisation, composition, mediation, lucid dreaming, dream yoga, and the like are able to access. Quite possibly these correlate in some way either with activity levels in the networks described here, in their within-network connectivity, and/or in connectivity across networks (whether facilitative or inhibitory, or a mixture of the two). Together with the cognitive modes that may be more consciously vigilant (such as the executively “controlled” transformative phase) or open to external influence (such as the evaluative mode, afforded by the salience network), this eclectic view of the large number of ways the mind appears to be used during creative musical behavior bodes well for neuroscience’s contribution to the developing understanding musical creativity in the mind and brain.

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Neuroscience: Pupillometry and Creativity

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Glossary

Attention a cognitive process of selectively concentrating on a discrete aspect of information while ignoring other perceivable information

Cognitive resources amount of activation available for information storage and processing the underlying cortical neural system

Locus Coeruleus a nucleus in the pons of the brain stem involved with physiological responses to stress and panic

Phasic pupillary response rapid fluctuation in the size of pupil

Pupillary constriction narrowing of the pupil also known as miosis

Pupillary dilation widening of the pupil also known as mydriasis

Tonic pupillary response elevated baseline size of pupil

Working memory a system responsible for the active maintenance and online manipulation of information over short intervals

Introduction

The pupil is the opening located in the center of the iris that allows light to enter the eye and reach the retina. The fact that the size of the pupil changes in various conditions was well known to early researchers. But in the last 50 years or so psychologists have been interested in the fact that changes in pupil diameter can index cognitive functioning. In general, the pupil dilates when participants are in condition of increased attention or cognitive load or of emotional or cognitive arousal. **Pupillometry is the study of such changes in pupil diameter as a function of cognitive activity.** Pupillometry is tightly linked to Locus Coeruleus (LC) neuron activation, which conducts the noradrenergic system in the whole brain. The LC and norepinephric system (LC-NE) are known to be involved in different processes including stress variation, memory retrieval or selective attention, on top of general functions such as arousal and the sleep-wake cycle. This entry explores the history and evaluation of pupillometry and how it is widely used in psychology to understand underlying neural mechanisms of various cognitive functions. There is also a discussion regarding how these functions relate to creativity and how pupillometry can be used as a tool to measure critical aspects of creative performance.

Brief History of Pupillometry and Its Measures

The word pupil comes from the Latin “pupilla”, which means little doll. It refers to the small reflected images one can see when looking in the eyes of another person. The fact that pupil size changes in various conditions was well known to early philosophers

and surgeons. The earliest records comes from Roman Physician Galen (129–216 CE) who used plants to dilate pupils during cataract surgery. Courtesans in medieval Italy used a special substance to dilate their pupils so that they could appear more attractive.

Early methods to measure pupil size variation were not very accurate and mostly relied on subjective observations by researchers in clinical setups. These researchers used various tools such as compasses, reticles, cross hairs and other optical devices or even black circle templates to find the best match with the actual size of the pupil. Later, the development of cameras allowed researchers to work offline on the still images of the pupil. Improvements such as increased number of pictures per second through cinematographic methods further allowed timeline representations of pupil size variations and they were called “pupillograms” (Lippold et al., 1967). But the process was still very tedious and time consuming. Researchers had to develop every picture, project each frame on a screen and then measure the pupil size with a compass or a ruler. However, in last few decades, pupillometry methods have expanded with the arrival of latest eye-tracking devices. Modern eye trackers are very accurate and allow monocular or binocular online automatic recording.

Pupillometry in Early Psychology

Researchers in ophthalmology and optometry have been aware of pupil behavior for a long time. But the interest in pupillometry in psychological studies as a reliable measure of various cognitive processes is more recent. While task evoked pupil response from psychological effects were noticed in the 18th century, understanding of this phenomenon was lacking. Many early studies were personal observations of single patients in clinical studies. For example, Lowenstein (1920) studied the response of a catatonic schizophrenic patient for emotion, comfort, pleasure and displeasure. In another study change in pupil size was measured by adjusting cross hairs on a short focus telescope in an experimental lie detection situation (Berrien and Huntington, 1943).

Significant early work in psychology was generated by Hess and his associates’ at the University of Chicago. In one study, Hess and Polt (1960) showed that pupil size variation could be considered as an index of “arousal” and “implicit processing,” by measuring pupillary changes to pictorial stimuli in four men and two women. Pupillary responses were scored in terms of the percentage increase in pupil size in a test slide compared to preceding control slide. Women displayed relatively larger pupil dilation when they looked at pictures of babies, mothers with a baby or nude males than to other pictures of people. Heterosexual men’s pupils were found to be larger when they looked at pictures of naked women. In another study (Hess, 1965), pupillary response of food deprived participants was at least two times greater than non-deprived participants when they looked at pictures of food. Hess interpreted pupil dilation in these kinds of situations as an index of “interest”, “emotion” and “motivation”.

Since then other researchers have followed Hess in using pupil size to measure “emotion”, “interest” and “attractiveness”. For example, one of the studies (Fitzgerald, 1968), reported greater pupillary dilation in infants to pictures of human faces than to geometric shapes and patterns and to a picture of their mother’s faces as compared to that of a stranger. In parallel to these studies using pupil variation to assess “arousal” and “emotional responses”, researchers also noticed the relevance of pupillometry to index mental load. For example, in a study, participants showed greater pupil dilation during mental multiplication task (Hess and Polt, 1964). The more difficult the problems, the more pupil diameter increased. The impact of cognitive load in a mental arithmetic task was replicated in several studies. Similar effects were also found in other areas of research such as sustained attention processing, working memory, decision making and so on.

Pupillometry in Recent Psychology Research

In recent psychology research, pupillometry is a widely accepted as non-invasive, online and reliable measure of cognitive processing. It is used in various psychological research areas such as perception, language processing, memory, decision making and so on. In perception studies, pupil size has been shown to dilate and constrict in various imagined scenarios suggesting top down processing (Laeng and Sulutvedt, 2014). Pupillometry has also been used to study Subliminal Mere Exposure Effect (SMEE) where participants are familiarized to stimuli they cannot consciously perceive. Pupillometry has been a useful index of visual processing in the attentional blink task, which assesses whether participants notice the second of the two stimuli presented in rapid succession.

In language studies, pupil diameter proves a reliable index to various alterations to verbal language including alterations due to hearing loss (Kramer et al., 2013). Pupil dilation indexes the difficulty of word retrieval in bilingual participants, correlating with both word frequency and neighborhood density. Increased pupil diameter predicted the wandering of attention during reading tasks (Franklin et al., 2013). Similarly in decision making tasks, pupil dilation predicts decision threshold when a choice is made. Studies show that pupillary response indexes the decision making process as compared to the outcome. Memory research suggests that pupil change reflects retrieval as well encoding (Guillory et al., 2013; Kafkas and Montaldi, 2011). Pupil dilation is thought to index the strength of the memory and reflects stress levels during encoding tasks.

Physiology of Pupil

The pupil is the opening of the iris that permits light to enter the eye and reach the retina. In humans and many animals (but not all, e.g., domestic cats), the pupil is circular in shape. In low light the pupil tends to dilate whereas in bright light it tends to constrict. This phenomenon is called *pupillary light reflex*. Pupil diameter can vary from 2 mm to 8 mm and reacts to stimulation in about 200 ms. Usually in standard light conditions, pupil size is about 3 mm.

Variations in pupil size is caused by two smooth muscles in the iris: the “sphincter” (or constrictor) and “dilator” pupillae. The dilator muscle is under adrenergic control (sympathetic system) from the superior sympathetic ganglion. The sphincter pupillae is innervated by cholinergic fibers of the parasympathetic system leading to the stimulation of the dilator muscle and a parallel inhibitory parasympathetic mechanism. Pupillary response caused by cognitive load is tightly linked to “Locus Coeruleus” (LC) neuron activation. The LC is a subcortical structure and is the conductor of the noradrenergic system in the whole brain. The LC and noradrenergic system (LC-NE) are involved in different processes including stress variations, memory retrieval or selective attention. Single cell recording in monkeys have shown close connection and correspondence between the baseline firing rate of a LC neuron and pupil size. A recent work uniquely highlights the close relationship between the LC-NE system and the pupil diameter change relating pupil dilation to fMRI recordings of the LC (Alnæs et al., 2014).

Moreover, researchers have shown that the LC displays two main activation profiles: “tonic” and “phasic” modes. Gilzenrat et al. (2010) suggested that these two modes are two ends of a continuum. The “phasic” mode represents neurons firing rapidly to optimize performance during a specific task to focus attention on an exploration mode. This LC activation leads to rapid pupil dilation. The “tonic” phase, on the other hand, is more efficient in sustained processing. This mode is associated with an elevated baseline firing rate in the LC. It promotes disengagement from the task and diffuse exploration.

Pupillometry and Attentional Resources

As early as 1920 researchers argued that dilation of pupil can be observed with every increase in attention by intellectual processes of every kind. Since then changes in pupil size has been studied as a function of attentional resource allocation. Generally pupillometry is considered discriminately sensitive to different components of attention, based on the onset, acceleration or duration of dilation events. In other words, the delay, speed and length of a change in pupil diameter index various aspects of attention. A similar usefulness of pupil dilation to the study of attention has been observed before stimulus onset (implying anticipation) by manipulating asynchrony between the target and distractor stimuli in a flanker task, a procedure that measures response inhibition. Pupil dilation has also been studied to indicate mental load. For example, in one of the studies, gradual dilation was observed beginning with the presentation of the problem and reaching its peak immediately before the participants’ verbal report. The mean extent of the dilation was directly related to the degree of problem difficulty. Subsequent studies provided repeated evidence for the ability of pupil size to indicate mental activity to differentiate among different level of task difficulty.

Pupillometry and Cognitive Resource Allocation

All cognitive efforts, like physical efforts and sensory stimuli, cause pupil dilation (Beatty and Kahneman, 1966). Studies demonstrated that the pupillary response reflects an overall aggregate of mental resource allocation that is not limited to a specific part of the cognitive system. According to this view the pupil could thus be used to map overall functional level of the cognitive system to the amount of activity in the underlying neural system. Researchers have argued that pupil dilation amplitude is a useful measure of task evoked resource allocation. The more difficult a task, the more the pupil dilates.

Of course the amount of resources that are allocated to a task does not depend only on the cognitive demands of the task but also on the intensity with which an individual engages in it. This intensity of task engagement might also be reflected in pupil size variation. It has long been known that pupil dilation increases with the activation of sympathetic nervous system. As the sympathetic nervous system regulates arousal a higher pupil dilation may indicate that an individual is applying himself or herself with more vigor to the task at hand.

Working Memory

Working memory is the system responsible for holding information available for complex cognitive activities such as language, comprehension, planning and reasoning—all those activities that involve the representation and processing of how two or more elements are related to each other. It has been explicitly implied in conscious, controlled and deliberate information processing: “What we are aware of at a given time is represented in this working memory, through which conscious thinking flows in a sequential manner” (Evans, 2008, p. 259). Working memory is operationally defined as the number of items that can be recalled during a complex task that requires simultaneous maintenance of information in an active state and the manipulation of information for computational purpose. In simple words repeating a phone number can be done using plain short term memory and does not require working memory. But a task to retain a phone number and repeating it backward or backwards while skipping all the odd digits requires working memory.

Working memory is thought to be capacity limited. Theoretically, the capacity limit arises because only four or so items can be individuated and maintained through the continued allocation of attention. The ability to actively maintain items in working memory is critically dependent on the ability to allocate attention to items within working memory. If attention is distracted by internal or external information, the representations are not maintained, and performance suffers. Thus, individual differences in the capacity of working memory should partially come down to differences in the amount of attention that can be allocated to items, as well as in the ability to control attention and prevent fluctuations in attention.

Studies have used pupillary response as an online measure of attentional allocation and fluctuations in attention in order to examine both how attention is allocated to items in working memory and individual differences therein. Results of these studies

indicate that items in working memory are maintained via the continued allocation of attention and that individual differences in the capacity of working memory are partially due to differences in the amount of attention that can be allocated to maintain items in working memory (Unsworth and Robison, 2015). This phenomenon is reflected in the pupillary response.

Pupillometry in Intelligence Studies

Pupil dilation also allows for discriminating between individuals who differ in intelligence. For example, Ahern and Beatty (1979) analyzed task-evoked pupil dilation in two groups of university students differing in intelligence (as indicated by their scores on the Scholastic Aptitude Test [SAT]) while they were solving mental multiplication problems across three levels of difficulty. Individuals with higher SAT scores showed higher accuracy and smaller task evoked pupil dilation than individuals with lower SAT scores. As both groups did not differ in the magnitude of luminance induced pupil dilations, the differences in the task evoked pupillary response were assumed to reflect differences in central brain processes, indicating that more individuals invested fewer responses. In this regard, it must be noted that most of the intelligence studies have revolved around two hypotheses: resource allocation and efficiency. According to the resource allocation hypothesis individuals with higher intelligence show greater pupil dilation while performing intelligence tasks indicating allocation of greater cognitive resource allocation. But according to the efficiency hypothesis, individuals with higher intelligence show less pupil dilation indicating allocation of fewer cognitive resources.

However, in one of the recent intelligence and pupillometry study (Lee et al., 2015), individuals with higher intelligence showed greater pupil dilation indicating allocation of greater resource allocation for tough tasks than individuals with lesser intelligence and they showed lesser pupil dilation for relatively easy tasks. Based on this result, authors argued that individuals with higher intelligence have the ability to modulate their resource allocation strategies which gets reflected in their pupillary response.

Pupillometry, Intelligence and Creativity

Pupillometry studies on creativity per se is difficult to find. However, pupillometry has been used to connect the relationship between general intelligence, creativity, resource allocation and working memory. Correlational studies connecting creativity with general intelligence are available, but they are mostly related to creative fluency (the amount of generated insights and ideas) more than to originality and novelty commonly seen as the hallmark of creative performance. For example working memory and creative performance correlates with general intelligence and general intelligence may account for shared variance between working memory and creativity. In one of the recent studies the relationship between creativity and intelligence was explored from resource allocation perspective using pupillary response (Ojha et al., 2017). The results showed that individuals with higher intelligence scores showed greater pupil dilation during creative interpretation of metaphors than individuals with lesser intelligence. The authors argued that creative cognition requires allocation of various cognitive functions and may share underlying cognitive and neural mechanisms with intelligence.

Pupillometry, Working Memory and Creativity

Working memory is intimately associated with language, reflective consciousness, higher order control and the capacity to think hypothetically about future and counterfactual possibilities. Similarly, studies in cognitive neuroscience and psychology suggests that for creativity to emerge, sustained attention and executive control may be desirable if not necessary. Such executive control involves working memory leading to the straightforward hypothesis that working memory capacity positively relates to creativity.

To date, however, research into possible links between WMC and creative performance is sparse and pertains to creative fluency (the amount of generated insights and ideas) more than to originality and novelty commonly seen as the hallmark of creative performance. Moreover, the existing evidence is correlational and open to alternate explanation.

However, working memory fulfills two basic functions: to keep novel information in a heightened state of activity and to discriminate between task relevant and task irrelevant information. These two functions are critical in creative performance. First, creativity requires the overriding of habitual tendencies such as generating the most accessible but common ideas and relying on initial perspectives and insights. Second, creative performance requires the combination of concepts retrieval from long term memory into new ideas and problem solutions (ideas cannot be generated ex nihilo but build on existing knowledge). Therefore, it can be argued that working memory is related to creative cognition.

Moreover, Dual Pathways to Creativity Model (DPCM) can further show how working memory is related to enhanced creativity. DPCM proposes that creative outputs such as insights and original ideas are a function of cognitive flexibility, of cognitive persistence, or some combination of both processing strategies. The flexibility pathway captures the use of flat associative hierarchies and manifests itself in divergent thinking. Flexible processing leads to insights and original response because it facilitates accessibility of remote informational links and finding new connections among categories and concepts. Flexibility pathways are characterized by relatively low levels of cognitive control, more or less “automatic” spreading of activation and mind wandering and higher distractibility. Therefore, this pathway seems to be less dependent on working memory.

“The persistence pathway”, on the other hand, captures the notion that creative insights and originality need more or less deliberate, focused and structured exploration of a few cognitive categories or perspectives. To arrive at original ideas and insights, therefore, requires focused use of the available time. Accordingly persistence manifests itself in the generation of many ideas within a few

categories and in a strong association between time-on-task and cognitive performance indicating that time was used effectively. This pathway seems to be dependent on working memory as it is involved in tasks that require sustained and focused attention. Thus, flexibility and persistence alone or in combination lead to creative outputs and maybe engaged during creative performance.

Pupillary response is an online measure of various cognitive mechanisms, particularly of working memory, attentional allocation and fluctuation in attention. Thus examining how attention is allocated to items in working memory can provide insights into creative performance as well as and its underlying neural mechanism.

Measurement of Pupillary Response

Change in pupil diameter can be measured using a pupillometer or eye-tracker, which allows both monocular and binocular data collection. To analyze the data from the eye tracker various statistical tools such as SPSS, Matlab, etc. can be used. Prior to statistical analysis, data is cleaned and artifacts due to excessive blinking is removed and very small blinks are replaced by linear interpolation. Usually small blinks are defined as missing data for less than 3 seconds. In general data missing for more than 3 s are not used for analysis.

Moreover, pupil size can also be affected by external factors like luminance of stimulus and gaze angles. To correct them, various computational methods can be used. Usually the pupil data with a big difference (1 mm) between the left and right pupil size is removed. In general, the pupil size range is about 3 to 6 mm according to intensity level. Therefore, pupil data beyond the range of 2 to 8 mm is also removed (see Jang et al., 2014).

Then the change can be represented in terms of actual change in mm as compared to baseline data or in percentage. Note that the pupil size varies for individuals and therefore a representation in change in percentage gives a more accurate picture to generalize the results. Moreover, to compensate for individual characteristics, pupil size variation of a baseline task is used. Assuming the baseline data to be 100%, change in pupil size can be represented using the following formula:

$$\left(\frac{\text{experimental data}}{\text{baseline}} - 1 \right) \times 100$$

Methodological Limitations and Concerns

Pupil size can be influenced by variety of factors therefore it is important to consider the following concerns and limitations while designing pupillometry experiments. First, while pupil size can double due to luminance variations, changes due to cognitive load or arousal is rarely larger than 0.5 mm. Second, although pupillary responses are generally voluntary, people can learn to induce pupil dilation by mentally manipulating their thoughts (e.g. thinking about sexual images or doing mental arithmetic). However, people cannot inhibit pupil reaction to stimuli. Third, when fatigue develops, the average size of the pupil decreases and begins to fluctuate remarkably. Fourth, pupil size fluctuations are common under the effect of drugs and medicines. Fifth, a history of participants mental state such as depression and mood can also influence the pupil size variation. Therefore, designing a pupillometry task requires that researchers pay attention to those details that can cause pupil diameter fluctuations independently of the study purpose.

Spontaneous Eye Blink Rate

Spontaneous Eye Blink Rate (EBR) is closely related to pupil dilation. Several studies showed that eye blinks do not occur randomly. Spontaneous blinks indicate cognitive processing as well as mild cognitive impairment. Until recently, pupillary researcher treated eye blinks as missing data and used to fill in estimates of pupil diameter during eye blinks with an approximation. However, some independent studies indicated that eye blink bursts follow high cognitive load or information processing. This suggests that eye blinks reflect the release of resources used in stimulus related cognition. Blinks potentially reflect preparation and very short blinks are associated with errors on cognitive tasks, consistent with adequate preparation.

Pupil and blink data have been shown to explain independent variance in cognitive processing over 10 second intervals. However, pupillary and blink information do not correlate; they are completely independent. Pupil dilation often follows blinks on a cognitive task, which suggests that blinks reflect initial stimulus processing or preparation for engagement of cognitive resources. And as the complexity of task increases, pupil size increases but eye blink rate decreases.

Blinks also indicate concealment of crime related memories and deception. Some studies have suggested that eye blinks are controlled by the central nervous system and tend to inhibit it during sustained cognitive load and attention demand. Other studies indicated that blinking is avoided to maximize stimulus perception during high attention tasks and blink occurrence is reduced increasing information content and task demands.

Some studies found correlation between levels of dopamine and spontaneous eye blink rate. Eye Blink Rate can be used as a predictor of convergent and divergent thinking. Therefore, it can be argued that pupillometry in combination with blink rate analysis may provide better measurement and understanding of creative performance.

Conclusions

Pupillometry has evolved as a robust and reliable measure of cognitive processing in the last few decades within psychology and cognitive sciences. Many technological and methodological advancements have turned a once tedious, expensive and time consuming procedure into a relatively easy online process. Cheaper eye tracking devices have further allowed researchers with modest means to make use of this method to understand underlying mechanisms of various cognitive functions. It is proving to be a useful method to study special populations who are not able or willing to provide typical behavioral answers to certain research questions. Although, pupillometry is only beginning to be explored in creativity research and its potential has not been realized, in the future it surely promises to provide important insights into underlying cognitive mechanism of creative cognition and performance.

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Neuroscience: Transcranial Electrical Stimulation

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Background

The cognitive neuroscience of creativity is chiefly focused on identifying brain regions and networks that support creative cognition. Because creative cognition draws upon neurocognitive processes likely to be cornerstones of higher cognition broadly, these neuroscientific inquiries have attempted to parse particular kinds of creative thinking and the patterns of brain activity that support them. That is, rather than devise experiments to identify the ‘creativity’ part of the brain that is engaged for the sole purpose of creative cognition (which is unlikely to exist), psychologists and cognitive neuroscientists most commonly endeavor to present an association between activity within a specific brain region or network and a specific task that putatively estimates a specific form of creative thinking.

The bulk of this work has examined the neural bases of creativity through the use of functional magnetic resonance imaging (fMRI) or electroencephalography (EEG), relating brain structure, activation, and/or functional connectivity with specific operations of creative thinking. Recently, however, a growing number of researchers have employed noninvasive transcranial electrical stimulation (tES) to experimentally induce transient changes in neural activity of target brain regions. Whereas fMRI and EEG are used by investigators to correlate neural activity with a behavioral variable, tES allows for manipulation. Thus, tES can provide causal evidence for specific brain areas involved in distinct creative operations and may represent a viable method to augment creative thinking, at least in the short term. Insights obtained through the use of tES have bolstered our understanding of the neurocognitive processes involved in creative thinking.

Transcranial Electrical Stimulation

tES, the application of low-level electrical current to neuronal populations of interest, is a safe technique that allows experimenters to temporarily manipulate spontaneous (sometimes called ‘intrinsic’) neural activity of specific brain regions via electrodes carefully placed on the scalp. Electrical current is passed through the skull (as well as the skin and cerebral spinal fluid) to a target region of cortex hypothesized to be involved in a particular cognitive ability or behavior. In order to effectively and safely stimulate the region of interest, expert technicians computationally model this current by accounting for the different electrical conductivities of the different structural elements between the electrode(s) and cortex – including differences in grey and white matter. The technique does not cause neuronal firing, but rather, briefly alters the resting membrane potential of target brain regions, rendering them more or less likely to fire. Furthermore, these changes are short-lasting; tES does not lead to complete rewiring of neural connections or permanent alterations in resting membrane potentials. Thus, when exploring the effects of brain stimulation on cognition, behavioral assessments are typically performed within minutes of neural stimulation. Some have begun to investigate the ramifications of repeated stimulation, but there is presently little evidence of enduring neural changes.

There are several kinds of tES, but the most commonly used technique – at least with respect to creativity research – is transcranial direct current stimulation (tDCS). Traditionally, tDCS designs operate by passing current between two large, saline-soaked sponges: a cathode/return electrode and an anode/active electrode. The resting potential of neuronal populations under the anode is believed to increase, making these neurons more likely to depolarize (i.e., fire). The reverse is true for neurons under the cathode; stimulation lowers the resting potential, which decreases the rate of depolarization. In this way, tDCS has been used to either boost (via anodal stimulation) or reduce (cathodal stimulation) activity of select brain regions. If a cortical target is involved in a specific cognitive operation, then modulating activity at said region should influence the cognitive process in question. Such an approach

lends itself to both within-subject (compare performance before and after stimulation) and between-subject designs (performance of stimulated participants vs. unstimulated participants). To account for possible placebo effects, most stimulation studies will include a sham condition in which electrodes are placed on the scalp but, unbeknownst to the participant, there is no application of sustained electrical current.

The appeal of tDCS rests in the ability to intervene on spontaneous brain function. There are, however, a number of complicating factors that can make interpretability and/or implementation difficult. First, because the current must pass through the skull, scalp, and CSF before reaching even the most superficial part of cortex, it is challenging to stimulate deeper brain regions. For example, despite a theorized role in creative cognition, the posterior cingulate has eluded experimental manipulation via tDCS. This is further complicated by the fact that, even if it were possible to consistently reach such a region, current must first pass through more superior neuronal populations. Any behavioral effects could be attributed to changes in these areas. This is an issue even for 'easily' stimulated brain regions, as the current must travel between the cathode and anode, potentially influencing the resting potential of neurons located between the electrodes. It can also be difficult to estimate where current terminates (i.e., current may spread out from region of interest). These matters are all at least particularly mitigated by high definition tDCS (HD-tDCS), a newer kind of tDCS montage that consists of one central anode surrounded by four return electrodes, allowing for more focal stimulation.

Lastly, some interpretations of tDCS rest on a presumption of regional independence that has not been sufficiently empirically demonstrated. At present, there is still little known about how applying tDCS to one brain region may alter brain networks and create downstream changes to other regions. The sum of these complicating factors means that, even if tDCS to Region A results in some sort of meaningful change to Behavior A, it can be difficult to demonstrate that the change stemmed from alterations to Region A alone, and not from Region B – which may have been stimulated as current passed through the brain to Region A – or from changes in Regions C or D, which may be nodes of a brain network that also includes Region A.

Despite these issues, tES has been used to influence a range of cognitive abilities such as executive control processes, performance-related anxiety, and, as shall be explicated in the coming sections, creative thinking. Thus, tES can be viewed as a tool to elucidate neurocognitive mechanisms through the demonstration of dissociable changes in behavior (Elucidation of Neurocognitive Mechanisms of Creativity). If tES designs can reliably alter creative thinking (even over only brief periods of time), then it may also be used to induce lasting boosts in cognitive functioning (Potential for Creative Augmentation). The remainder of this chapter is devoted to these two uses.

Elucidation of Neurocognitive Mechanisms of Creativity

Creative cognition is most commonly said to rely on at least two primary operations: (1) divergent thinking, which refers to the expansive generation of novel ideas, and (2) convergent thinking, honing in on a single response from a number of possible alternatives. These two operations are typically measured with different creativity tasks that presumably depend more heavily on one or the other (although both divergent and convergent thinking are likely to be involved in any given creativity task). A standard – albeit imperfect – practice in the neuroscience of creativity is to specifically target one of these operations (through a certain task) and identify a brain region or network that correlates with behavior. Together, divergent and convergent thinking lead to what is commonly understood as creative cognition: cognition that results in ideas that are novel and useful. Given the complexity of creative cognition, it should come as no surprise that the effects of using tDCS to investigate the neural bases of creativity vary widely by task domain (i.e., divergent or convergent), polarity (anodal, cathodal), and stimulation site.

Divergent Thinking

Divergent thinking is theorized to depend on the availability of unfiltered, low-level perceptual information. In other words, individuals may display superior divergent thinking abilities when top-down control is reduced, thereby allowing for the consideration of a greater number of possible ideas and solutions that may be otherwise prematurely rejected. For instance, if one is asked to consider alternative uses of a brick, less inhibition may lead someone to generate more possible solutions. Scores on divergent thinking are typically derived based on the number of valid ideas an individual is able to produce, thus generating a larger number of potential solutions is likely to correspond to greater creativity. This line of thinking has received some support from tDCS experiments.

Across a number of studies, researchers have used cathodal stimulation to reduce the cortical excitability of left lateral prefrontal cortex (PFC), including left inferior frontal gyrus (IFG), a brain region with a well-established role in inhibitory control processes. Stimulation of left lateral PFC regions has led to improved performance on creativity tasks with an emphasis on divergent thinking. In one such study (Chrysikou et al., 2013), participants performed a variation of the traditional Alternative Uses Test (AUT) for which they were instructed to generate either common (non-creative) or uncommon (creative) uses for a set of everyday objects. Subjects who received cathodal tDCS over left PFC were faster to generate creative uses compared to sham. Notably, this was not observed for the common/non-creative condition – a dissociation that suggests that a hypofrontal state characterized by less top-down inhibition can boost performance on divergent thinking tasks that rely on unfiltered, bottom-up information (i.e., generating creative, uncommon uses), but not for tasks that depend on access to well-rehearsed knowledge (i.e., generating common uses). Other work has extended these findings. Cathodal stimulation of left IFG improved divergent thinking performance, while

anodal stimulation – which putatively increased inhibitory control – hampered creative production (Ivancovsky et al., 2018). Similarly, cathodal stimulation of left IFG increased fluency (i.e., number of ideas generated) and flexibility on an alternative uses task, but only when paired with anodal stimulation over right IFG (Mayseless and Shamay-Tsoory, 2015), rendering this result somewhat difficult to interpret.

Taken together, these studies provide some direct, experimental support for neurocognitive theories of creative cognition that emphasize the role of disinhibition during divergent creative thinking. Decreased spontaneous firing in brain regions involved in inhibitory control augmented divergent thinking. This suggests that individuals who display superior divergent thinking abilities may be better at disengaging cognitive control processes.

Convergent Idea Selection

If divergent thinking is about unrestricted expansion of thought, then convergent thinking can be viewed as the opposite; it is about directing thoughts towards a specific goal, evaluating the appropriateness of potential solutions, and ultimately choosing the optimal one based on the task at hand. Convergent thinking stems from one's ability to integrate concepts that may initially appear to be semantically unrelated. However, it cannot be overstated that seemingly all creativity tasks are likely to rely on both divergent and convergent thinking, making it difficult to truly assay these two processes and the neural mechanisms that give rise to them. That said, if a task depends more heavily on convergent thinking, then alterations to the resting potential of brain regions involved in idea selection and integration may improve task performance.

One brain region that fits this description is dorsolateral prefrontal cortex (DLPFC), which is involved in executive function, including promotion of task-relevant thoughts and suppression of inappropriate ones. Since convergent thinking is theorized to benefit from these mental operations, amplifying the spontaneous firing of DLPFC may lead to improved performance on convergent tasks. The Remote Associates Test (RAT) is the most frequently used measure of creative convergent thinking. The RAT approximates convergent thinking by providing participants with three seemingly unrelated words (e.g., 'Fish, Mine, Rush') and requiring them to identify a fourth word that forms a compound association with all three ('Gold'). There is a clear emphasis on appropriateness and selectivity – several possible solutions may connect two words, but only one links together all three. Consistent with this explanation, anodal – but not cathodal – tDCS of right DLPFC has been shown to improve RAT scores (Cerruti and Schlaug, 2008). Increasing the excitability of a region with a previously-established role in directing task-appropriate thoughts improved convergent thinking, whereas decreasing regional excitability did not. Furthermore, the same stimulation setup (i.e., anodal tDCS of right DLPFC) did not produce enhancements on a primarily divergent task. This separation indicates that, in accordance with prevailing theories of creative cognition, divergent and convergent thinking may be conceptualized as (at least partially) different forms of cognition with (at least partially) distinct neural bases.

The Thinking Cap Effect

Humans are able to deliberately think more creatively when provided with explicit instructions to do so. This so-called thinking cap effect demonstrates that creativity – in addition to being a trait that varies among individuals – can also be viewed as a state that is subject to change over time based on task context and goals. In looking at the tDCS literature as a whole, the overall body of work indicates that cognitive improvements are largest when paired with behavioral interventions (e.g., cuing or priming) that are likely to engage the same neuronal populations targeted by the electrical stimulation. This suggests that the effects of tDCS may be greatest when applied alongside a cue to 'think creatively'.

Another part of the brain likely to be involved in creative thinking – especially as it pertains to intentional increases in state creativity – is frontopolar cortex. Although the precise role of frontopolar cortex is not fully understood, it appears to be engaged for the purposes of combining pieces of information and integrating abstract representations. As previously noted, one of the great benefits of tES rests in its ability to extend prior correlational imaging work. This has been done particularly well with respect to the thinking cap effect.

After identifying left frontopolar cortex as a brain region associated with creative state enhancement during a verbal relational thinking task (i.e., more activity in this brain region was associated with a larger cue effect; Green et al., 2015), a follow up study (Green et al., 2017) was performed in which participants received anodal HD-tDCS to the same brain region while they completed similar relational thinking tasks. For one task (the matrix task; Weinberger et al., 2016), participants were explicitly cued to think creatively while they selected word pairs from a large matrix to form valid and creative analogies. In the second task (verb generation; Prabhakaran et al., 2014) participants were provided with noun prompts onscreen and asked to generate related verbs. They were cued to think creatively on half of the trials. Compared to those receiving sham, participants with anodal stimulation to left frontopolar cortex displayed significantly improved creative performance on the matrix task (which was always accompanied by a cue). On the verb generation task, there was a tDCS × Cue interaction for which maximal creative performance was observed when participants with anodal stimulation received a cue to think creatively. Together, this study highlighted the role of a specific brain region (in this case, left frontopolar cortex) in a specific creative process (thinking cap effect for relational thinking) by directly intervening on spontaneous brain activity.

It should also be noted that, by providing explicit instructions to think creatively, selectivity demands were effectively increased, further emphasizing the role of convergent thinking. For example, on the verb generation task, rather than name the first verb that came to mind, the cued participants had to search for more semantically distant connections and – from a now-larger collection of

potential solutions – pick the most appropriate option. This kind of reasoning is a defining characteristic of convergent thinking. Since frontopolar cortex appears to be involved in combining and integrating information, it would follow that activity in this brain region may increase when cued to think creativity because of a greater need to combine and integrate information. Additional work supports the interpretation of cue = greater selectivity. Anodal stimulation of DLPFC augmented performance on a convergent task but had no effect on divergent thinking (Zmigrod et al., 2015). However, when the same stimulation design was paired with explicit instructions to visualize using an object in an usual way (thereby increasing the number of possible ideas and the need for convergence/selectivity), tES did enhance divergent thinking (Colombo et al., 2015).

Potential for Creative Augmentation

The prior section provided an overview of some of the ways in which tES has been employed to provide causal evidence in favor of a specific brain region's involvement in a specific form of creative cognition. By applying electrical current to task-relevant brain regions, experimenters have been able to manipulate one's capacity to think creatively, but even the most promising findings in this area have come far short of demonstrating that tES is a viable way to induce long-lasting behavioral effects. However, transient improvements in creative thinking introduce the possibility of more enduring benefits, and open the door for a nuanced discussion regarding how/when such techniques may be utilized to boost creative thinking.

Treatment of Enhancement?

Should the use of brain stimulation to augment creative thinking be considered a treatment (i.e., something deemed therapeutically necessary for a healthy and/or normal life) or an enhancement (a non-medical improvement for career advancement and/or life-style changes)? The answer to this question could result in very different regulations pertaining to the use of tES for creative cognition. Broadly speaking, the use of brain stimulation to increase a specific form of cognition is commonly viewed as an enhancement, and this seems appropriate if one conceptualizes creative thinking as something involved in artistry or technical innovation. For example, an accountant who desires to be better at musical improvisation would have a difficult time claiming that becoming a better musician is medically necessary.

But what if the same accountant argues that their creative abilities are so poor that they have become clinically depressed? While one option would be to treat the depression itself, would it not also be appropriate to fix the cause of the depression (i.e., a lack of creativity)? In this instance, if tES were found to ameliorate mental health by restoring or improving some degree of creative thinking – even if it were just one part of a collection of clinical interventions – then it seems as though the treatment label may still be appropriate. Furthermore, generative and flexible thinking – cornerstones of creative cognition – are likely to have widespread utility. While it would be inaccurate to describe aphasia as a disorder of creativity, one could argue that aphasics who struggle to verbally express themselves may become anchored on certain words, and their inability to articulate a thought could be described as an inflexibility. Hypothetically, using tES to improve generative abilities – much in the same way that it may be used to increase the number of words a participant can generate during the AUT – could relieve some aphasic symptoms (again, along with other treatments). This illustration is speculative, but serves to demonstrate the challenges in deciding how best to classify efforts to use tES to foster creativity.

Relatedly, there is also the question of access. If the use of tES is classified as a treatment, then individuals could ostensibly have the cost of purchasing and maintaining a device at least partially covered by health insurance. This, in turn, would create an avenue by which a large percentage of the population may be able to obtain tES equipment to augment creativity. Alternatively, if deemed as an enhancement, medical coverage seems unlikely to be obtained. As a consequence, the theoretical benefits of recurrent use of tES would be offered to only the members of society with the financial means to purchase and use the devices. Such income-related differences in access would hardly be something new (e.g., private education, higher quality produce), but represent just one possible result of tES classification.

Contexts of Use

Deciding whether to classify tES-based augmentation of creativity as a treatment or enhancement may be a worthwhile exercise, but using brain stimulation to induce lasting changes is not presently feasible. A more pressing matter concerns contexts of use. tES devices are, at the time of writing, easily obtainable as direct-to-consumer products marketed for a variety of uses, such as improving mood and attention. These devices are designed to be safe, but unsupervised home users who wish to improve their creative thinking may not heed the provided instructions, increasing the possibility for misuse. Complicating matters further, a burgeoning do-it-yourself community has developed methods to modify commercially available products or simply make their own devices from scratch for the purposes of improving a number of cognitive abilities. Home-made devices are not bound to any safety standards, furthering increasing the potential for risk to the user. These matters are particularly concerning if individuals apply electrical stimulation to children, as little is presently known regarding how electrical stimulation impacts the developing brain. Creative thinking is a prized ability in modern society, and parents and/or teachers may wish to fortify it to bring about long-term professional success.

In looking at the collection of empirical studies described earlier, it is apparent that short-term facilitation of certain kinds of creative thinking is possible. Critically, however, because creativity is a construct that pulls from several different cognitive processes, there is a complex interaction between current (anodal, cathodal), stimulation site, instructions, and task. All research was carefully guided by prior neuroimaging and behavioral investigations that identified specific neural mechanisms that support distinct creative processes. Researchers are not merely zapping the creativity part of the brain. For this reason, it seems unlikely (although not impossible) that home-users would be able to target specific brain regions to induce changes to corresponding forms of creative thought. Furthermore, as noted at the beginning of this chapter, optimal tES electrode placement and current is determined through sophisticated modeling conducted by expert technicians. Direct-to-consumer devices, as well as those made and/or modified by home users, are typically more constrained than tES hardware used in the laboratory, meaning that, even if the correct brain region is targeted, limitations on delivery parameters may prevent users from obtaining the effects that have been reported in the literature. Outcomes achieved in the laboratory environment may not be predictive of effects in the home or school settings.

In reality, however, it is likely that use in the home and school setting will occur regardless of these hurdles, making it vital to evaluate if and how tES should be used in such contexts. The outright banning of certain kinds of equipment and use would be difficult to enforce, and may only drive this growing community of users further underground and away from potential regulation. Accordingly, many have argued that the inevitability of use outside of the laboratory setting obligates researchers and policy-makers to work together to more thoroughly evaluate in-home use and directly engage with the do-it-yourself community and commercial manufacturers.

Conclusions

The use of tES affords researchers the opportunity to experimentally manipulate, rather than passively observe, the relationship between neuronal activity and creative cognition. One prominent theory of creative cognition posits that reducing inhibition allows for a greater consideration of possible ideas, which in turn increases the capacity for divergent thinking. Convergent thinking, on the other hand, is believed to stem from executive function and the promotion of task-relevant thoughts. Both of these neurocognitive explanations have received some support from tES experiments. Reducing the excitability of brain regions implicated in inhibitory control induced improvements on primarily divergent tasks while increasing the excitability of frontal brain regions that contribute to goal-directed thought yielded better convergent thinking scores. When paired with an explicit cue to think creatively during relational thinking tasks, anodal stimulation to brain regions involved in information integration (i.e., frontopolar cortex) produced significant gains in creative performance. Similarly, anodal stimulation to DLPFC improved thinking on a primarily divergent thinking task when accompanied by a cue that increased selectivity demands.

At present, the primary value of tES rests in how it can be used to better elucidate the neurocognitive bases of creative cognition; the reported boosts in creativity are short-lasting. However, projecting into the future, there is little doubt that such augmentation may further infiltrate the public interest, leading to in-home use of tES for the purpose of generating lasting improvements in creativity. This introduces a number of significant neuroethical issues related to how such interventions should be allocated and regulated. Prior work has recommended a multistep process that can evaluate the utility of using tES to influence cognition while simultaneously taking efforts to mitigate risks by determining when, why, and in whom the technology should be used. As research continues to explicate the neural substrates of creative cognition, these issues will become increasingly pertinent.

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Nonlinear Dynamical Systems, Chaos Theory, and Creativity[☆]

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Glossary

Attractor A region in the space describing the conditions (states) of a system, toward which the system will tend to go and tend to stay. *Strange attractors* characterize chaotic behavior and consist of confined trajectories that both converge and diverge, the system never in the same state and moving the same direction twice.

[☆] *Change History*: June 2019. David Schuldberg & Shan Guisinger updated the text throughout the article.

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Bifurcation A system's qualitative transformation, accessing new states, changing its dynamics, or attractor. [Stephen J Guastello and Liebovitch \(2009, p. 1\)](#) provide an example of change from one type of system into another, from one with periodic motion to chaos. *Catastrophe* is a similar term, generally referring to discontinuous change in a system (Guastello, 1995).

Chaos A class of dynamic behavior in deterministic systems characterized by sensitive dependence on initial conditions, diverging but constrained trajectories that imply unpredictability, and complex organization or structure. *Complexity* is sometimes a synonym.

Complex Adaptive System (CAS) Systems whose elements, or *agents*, learn from interactions with one other ([Holland, 2014](#)).

Dissipative systems Systems, such as living systems and forming snowflakes, that use up energy. Also referred to as systems *far from equilibrium* or at the 'edge of chaos.'

Emergence The perhaps sudden appearance of a new regime of system behavior or a new system, such as from a periodic to a chaotic system. Includes the *emergence* of new forms, structures, patterns, or organizations. *Fractals*, or the formations of convection currents as water heats up, are examples.

Fractal A pattern with similar structure at different magnifications, 'self-similarity' at different scales; strange and other complex attractors generally have discernable fractal structures.

Nonlinearity A relationship between two variables or a causal relationship between components of a system that is *not* strictly proportional and thus cannot be represented as a straight line graph on ordinary graph paper.

State space A space containing representations of the possible conditions or locations of a system. A location in '*phase space*,' sometimes synonymous, describes not only the current condition ('state') of the system but also its velocity, and where it is heading next.

Stochastic Random, operating according to probabilities, as opposed to processes or systems that are *deterministic*. NLDS are *deterministic* and not *stochastic*.

Systems theory Theory describing the behavior of composite entities composed of changing, interacting, and connected parts or units whose functioning emerges from the mutual influences of the parts. Characterized by modularity, interconnectedness, holism, emergence, the whole being greater than the sum of parts.

Introduction

Nonlinear dynamical systems (NLDS) theory, popularly known as chaos theory, is an exciting area of mathematics with increasingly productive application in the physical, biological, and social sciences. Initially attractive because of their great metaphorical appeal, NLDS also add rigor, realism, and explanatory precision. This article describes how they help illuminate creativity, a seemingly magical phenomenon eluding easy explanation since ancient times. Such difficulty in itself may indicate it is a good candidate for NLDS explanations.

Chaotic or near-chaotic systems can demonstrate amazing flexibility and adaptability. Despite connotations of 'chaos,' they can show order, complexity, and self-organization. Relatively simple, mechanistic, non-random, completely deterministic systems – called here *Somewhat Complicated Systems* (SCS; [Schuldburg, 2002](#)) – are capable of both regularity and surprising change. The theory is finding specific application to human processes including consciousness, cognition, perception, motor behavior, affect, learning, development, attitude formation, social interaction, personality, and psychopathology. Applications are developing rapidly as new phenomena are explored with new models and related data analyses, applicable at both low-level or micro (e.g., neurochemical) and larger macro (e.g., societal), levels. This entry applies NLDS to theories and data about creativity.

Dynamical Systems: Linear and Nonlinear

NLDS theory describes the behavior of systems that change with time; this is what 'dynamic' means, classically referring to actions of forces producing motion. Secondly, it applies to systems where at least one relationship among the components is nonlinear.

Linear Dynamical Systems

In contrast, much work in mathematics and science historically has focused on linear systems, where change in one part results in proportional change in another; in these, the relationship between the magnitude of a variable and its effect on a second variable can be represented graphically by a straight line on ordinary graph paper.

Fig. 1 depicts a simple linear dynamical system consisting of a block resting on a frictionless surface. It is attached to a solid wall by a 'linear' spring whose restoring force is proportional to how far it is pulled or pushed (x).

$$F = k_1x$$

A graph of this equation – relating the spring's force and how far the block is pulled – is a straight line (**Fig. 2**, dotted line).

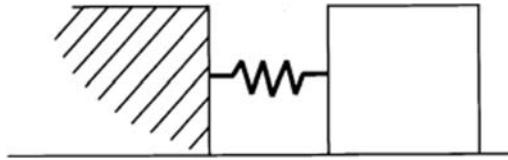


Figure 1 A linear dynamical system.

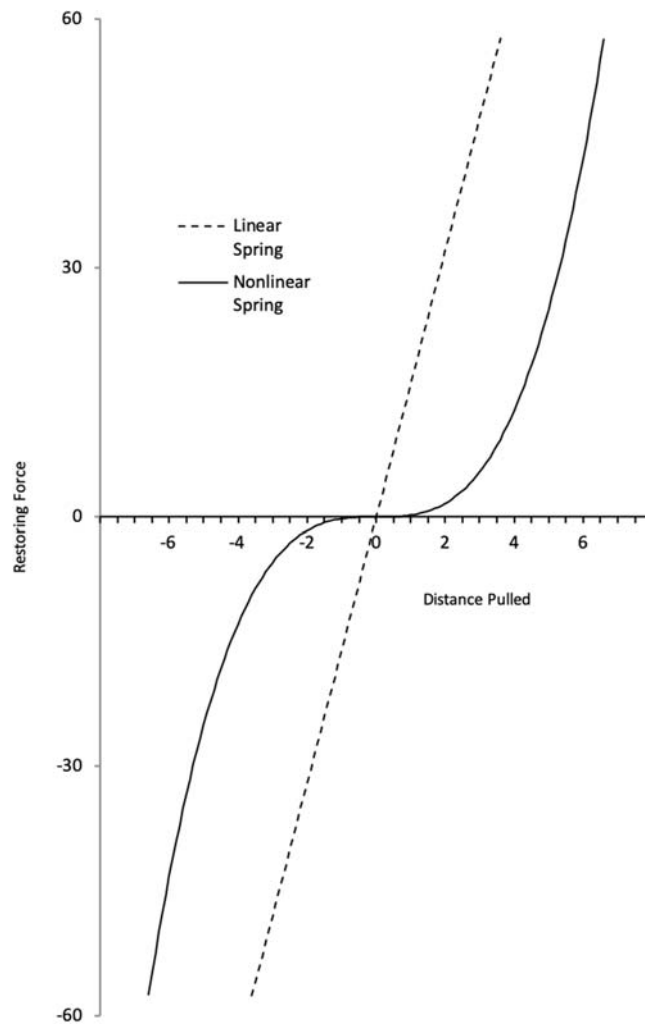


Figure 2 Linear and nonlinear springs ($k_1 = 16$; $k_2 = 0.2$).

If the block is drawn and released, it oscillates back and forth in a smooth, identically repeating pattern, easily modeled as a simple function of time. Linear systems have many desirable properties. Effects can be computed or disassembled as weighted sums of parts; they are often amenable to exact (analytic) mathematical solutions that precisely describe and predict their behavior. Research in psychology has mainly emphasized linear models. The product-moment correlation coefficient tests fit to a straight-line relationship between variables.

A Nonlinear Dynamical System

In contrast, NLDS theory studies situations where the relationship between one variable and another is represented by something other than a straight line. Nonlinearity is the rule in nature, with linearity a special case and often-useful simplification.

Discontinuous or all or none responses, such as the threshold firing of a neuron, are nonlinear ones. Another example is the restoring force of a nonlinear or 'hard' spring:

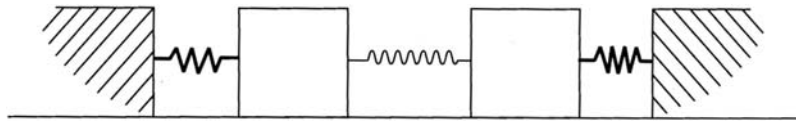


Figure 3 A nonlinear dynamical system.

$$F = k_2 x^3 \quad (x^3 \text{ is the nonlinear term})$$

The graph of force and distance pulled (x) for this spring is definitely *not* a straight line (solid curve).

Fig. 3 shows a small nonlinear mechanism constructed of two systems from **Fig. 1**, coupled in the middle with a nonlinear spring. With certain settings (springiness of the springs, masses of the blocks) it exhibits chaotic behavior.

Nonlinear Dynamical Systems in Life and Social Sciences

What specifically makes a system a nonlinear one? Discontinuous responses, ones that level off or drop, time delay, double-edged characteristics, and interactions among variables – all these introduce nonlinearity. NLDS can provide not-very-complicated causal models compatible with our experiences and observations of complex, patterned, often unpredictable behavior in ourselves and other living things. Despite being completely deterministic, their behavior can seem disorderly, noisy, random, alive! They also show surprising order and organization. Weather seems to change randomly but actually runs by the deterministic laws of Newton. The formation of snowflakes – nonidentical, but similarly formed – follows strict symmetry and results in uniquely beautiful objects.

NLDS' behavioral complexity promises ecologically valid explanations of real-world processes. But, they can be hard to work with and difficult, although not always impossible, to solve mathematically. This is one reason many avoided them before our widespread access to very powerful computing tools. You do not need to be able to solve their equations to use NLDS in research; broadly available software allows modeling, visualization, and simulation of diverse interesting systems.

Interesting Behaviors and Characteristics of NLDS

Some of these characteristics are associated with NLDS in general; others, such as strange attractors, apply specifically to chaos and complexity.

Temporal Change (Dynamics)

By definition, dynamical systems (both linear and nonlinear) change. Human activity is change with time. Psychological and social systems are in flux. Despite longitudinal approaches, much research still utilizes cross-sectional (single time) data or emphasizes the short-term, such as from pre- to post-test.

Unpredictability: Sensitive Dependence on Conditions

For some systems behavior is easily forecasted, for example, the linear device in **Fig. 1**. Others don't have mathematical solutions. There are two issues here. One concerns reducing systems' motion to an equation, solving a system 'analytically.' This can be difficult for many nonlinear systems, chaotic or not. The second: NLDS can enter regimes of chaos. A defining characteristic of chaos is *sensitive dependence on initial conditions*, where small differences in beginnings lead to large differences later; this also holds for outside perturbations. Small unknowns at the start of a story, environmental input, subtle influences along the way, all might have big consequences; this is the main sense of the famous 'Butterfly effect.' Visualizing the changing *phases* (see below) of a system as describing a track over time, very close paths can diverge radically later on. Unless its position and motion are known exactly, one cannot say accurately where the system will be later. This limits our ability to predict the future or ensure what happens next, as with the weather more than two weeks out and the course of a life.

While this may seem superficially similar to *Quantum Uncertainty*, the Heisenberg Uncertainty Principle operates only at extremely small, subatomic scales. The unpredictability of our larger-scale, chaotic, creative bio-psycho-social systems does not come from minute Heisenberg or quantum effects. Rather, macro-level unpredictability is fully compatible with completely Newtonian (non-quantum, non-relativity, pre-Einsteinian) physics and mechanics. This distinguishes deterministic chaos from quantum uncertainty, and from the true randomness of genuinely stochastic, chance, non-deterministic processes.

Social scientists generally use deterministic models, yet remain puzzled by failures at prediction and control in behavior, policy, and intervention; lives can thwart even our own attempts to steer them. But, difficulties in forecasting and control are simply properties of real life in a nonlinear (but still non-random) world.

Some Regularity Without Identical Repetition

Variability in systems has been attributed to noise, measurement error, and the effects of extraneous variables. However, it is often instructive to ask whether observed fluctuation actually represents data. NLDS analyses can expose patterning and processes

underlying seemingly meaningless change when we attend more closely to apparently random fluctuation, unexpected blips and swings, near-regularity, complex repetition, contained cycles, stable oscillation, and dynamic 'equilibria.'

This extends interest to bifurcations, both positive as well as negative feedback loops, unstable equilibria, and dynamic 'stationary states.' Much human behavior appears only approximately regular and sometimes 'out of the blue;' homeostatic regulation is chaotic, allowing reorganization, adaptation, development, and resistance to inner and outer perturbation or entrainment.

Bifurcation and Catastrophic Change

Another characteristic of dynamical systems is the possibility of bifurcation, qualitative system transformation with access to new states, splits into different kinds of dynamics, or changes in an attractor (Guastello and Liebovitch, 2009, p. 14). A system may shift from periodic to chaotic with different parameter values. The appearance of new systems is one meaning of 'emergence.' Some of these shifts are called catastrophes or represent 'tipping.' Seemingly discontinuous and radical psychological changes include psychotherapeutic Aha! Experiences, or an alcoholic's 'falling off the wagon' or committing to sobriety. These are modeled by catastrophe theory, a part of NLDS theory.

Chaotic and Complex Behavior

Not all NLDS are in chaos; however, the possibility of chaos is a very compelling feature.

A system's *phase* refers both to the location of its elements at a given time, and to where it is heading next. An *attractor* defines a region in *phase space* where a system tends to go, linger, or stay. A *fixed-point attractor* represents a unique place a system approaches and remains. If friction is added to the system in Fig. 1, the block will slow and eventually stop; this attractor is a point in phase space. A clock pendulum describes a *periodic* or *limit cycle* attractor; keep the mechanism wound and the pendulum returns to the same regular swing even if bumped.

In contrast, the never-repeating paths of chaotic systems are characterized by 'strange' attractors (a term that still delights after nearly 50 years). Viewed in phase space, chaotic systems never precisely go through the same place with the same velocity (speed and direction) twice. These regions in phase space contain ever-different, never-crossing paths. Close-together but not identical points can diverge, with vastly different outcomes later. Strange attractors are ever-changing, with originality and constant innovation; they include both order and disorder, convergence and divergence.

Scaling, Symmetry, Self-similarity, and Fractals

Strange attractors have interesting structures, including fractal patterns, self-similar at different scales. Similarity over different instances, temporal scales, and locations is related to Wittgenstein's 'family resemblance concepts,' and to the notion of creative 'style' across works, materials, and career. Self-similarity but not self-identicalness also provides an account of people's consistency in the face of the flamboyant self-contradiction central to the human soul. Obvious at different scales, consistency does not mean people will do the same thing, even in similar situations. Approaching personality styles as strange attractors with fractal structure reconciles personal identity and behavioral variability. Similarities across scale are common in clinical psychology in 'miniature' enactments of life issues in therapy, recapitulations of old interpersonal patterns (Marks-Tarlow (2008)). This 'parallel process' represents interpersonal self-similarity, like re-capitulation and re-figuring across levels and scales in archetypal processes in art.

Because of their scale properties, fractal phenomena also demonstrate interesting 'inverse power law' or 'long-tailed' distributions rather than familiar bell-shaped curves. Also visible in temporal phenomena like a faucet dripping, fractals suggest combined linear and cyclic versions of time and space. Seemingly predictable epochs are regions around attractors, entered, orbited, and left; at these times, life appears repetitive, with nearly symmetrical beginnings and endings, rising and falling narrative-like episodes. Then the story changes, reversal, new attractors.

Dissipative Systems and the Edge of Chaos

The edge of chaos occurs in high energy (far from equilibrium) systems that have neither 'blown up' nor settled around an attractor into chaotic or some other order. These systems use up energy, are dissipative. The 'edge of chaos' is like the point before freezing and prior to the formation of a snowflake, a zone where emergent order can appear.

Emergence and Self-organization

Stuart Kauffman (1992), Ilya Prigogine, and others have described how near-chaotic systems self-organize. Surprisingly, even as entropy inevitably increases, more and more complex organization can develop. This was recognized by Alan Turing (in 1952!). Sally Goerner (1995, p. 26) writes, "... the growth of complexity (evolution) is an energy-flow rate phenomenon. ... self-organizations always increase the rate of energy transfer. ... [S]ystems ... go through a series of organizations and reorganizations as part of accelerating energy flow. Driven energy flow phenomena ... lead to a series of increasingly complex and intricately ordered patterns." This growth in organization does not contradict the second law of thermodynamics in the bigger picture; emergent new patterns in dissipative systems actually make transfer of energy more efficient and accelerate systems' rush toward entropy. Kauffman called this rising complexity 'order for free.'

Application to 'Intractable' Problems

Much about human life is difficult to account for, not just its evading self-steering and defying intervention. Certain problems are notoriously difficult and appear insoluble, 'complex,' 'perverse,' 'wicked,' or they 'bite back' (Tenner, 1996). It is useful to look for

cases precisely where older methods have failed; noted dynamics researcher and cardiologist Ary Goldberger (Goldberger and West, 1987) referred to problems “whose only apparent unifying theme was their ‘resistance’ to traditional models.” Refractory phenomena can become comprehensible, rational, and potentially amenable to modeling when we seek underlying NLDS processes using biological, psychological, and social models.

Nonlinear Dynamical Systems Themselves

Psychological phenomena manifest many of the characteristics of NLDS behavior in their unpredictability, mystery, changeability, robustness, adaptiveness, and fit to an environment; models explaining them, if they include nonlinear relationships, can be just plain simple and still account for the complexity in their behavior. Instances of cybernetic, opponent-process, and dialectical phenomena are widespread, with models relevant to creativity. One example is the dialectical interplay of lifelong strivings for individuality and interpersonal relatedness (Guisinger and Blatt, 1994). Such phenomena are amenable to modular, interacting, sometimes hierarchical models, combined LegoTM-style (Csete and Doyle, 2002). Aggregates are enriched by the complexifying consequences of nonlinear linkages.

Where’s the Nonlinearity?

Some nonlinear relationships and equations have already been mentioned. In general, adaptiveness, health, and wellbeing do not just follow in straight-line, increasing fashion from positive behaviors or virtues; even a medium is not always a happy one. Nonlinearities in psychology include Hebbian or Yerkes–Dodson-type inverted-U curves, discussed below.

Closed and Open Systems

Many current models assume systems that are self-contained, closed, isolated from other systems and the environment, as well as systems at what is called ‘thermodynamic equilibrium’ (which in some ways resembles stillness). In contrast, open systems exchange inputs and outputs with their surroundings. Our bodies, minds, even our genes transfer material and information to and from physical and social environments. This has important implications for the complex structures of our lives and work.

NLDS and Chaos Theory in Creativity and the Arts

The remainder explores how concepts from NLDS apply to core problems in creativity theory and research.

Time and Creativity

Creative productions necessarily appear dynamically, in motion and process; even an ‘instantaneous’ and spontaneous flash of insight unfolds over time. Creative activities have been described with stages of generativity and consolidation, incubation, intimation (Wallas, 1926), elaboration. ‘Regression’ and ideational fluency also unspool temporally. Productivity develops over a life span as works’ meanings and realizations are modified in cultural and historical contexts, the creator’s experiences and life stage, shifts in approach and technique. Performance explicitly includes time.

Genres and movements are pushed along by generations of participants. Cultural diffusion, innovation spreading, acquisition of craft and expert skill, all unfold in time, as do grasping a new idea or paradigm, trying it, and making it one’s own. New ideas, tastes, aesthetics, and movements can oscillate. Colin Martindale observed how fashion changes incrementally. A style goes (what is later called) ‘too far’ and a trend reverses. Neckties become wider, narrower, wide again. Swings can be understood with linear models too, but style dynamics may well involve chaotic rather than periodic attractors; the past does not repeat precisely and styles don’t return the same. Nostalgia, neo-this or that, irony, sentimentality, snark, defiance, youth reclaimed – all can nest in ‘retro.’ If ‘revival’ is a strange attractor, ‘old school’ is not quite the past. The leg warmers of 2019 look almost nothing like those of 2009, which themselves were similar but not quite the same as back in 1989.

Empirical creativity researchers, despite attention to process, have often taken static trait approaches; an example is treating divergent thinking as an individual capacity varying across individuals, rather than a within-person process of problem-solving.

Unpredictability: Sensitivity to Initial Conditions and Nudges

Unpredictability may be a hallmark of creative activity. The trajectory of where a work will go cannot reduce to simple, solvable equations. This is not to say that practicing and understanding creativity completely resists use of deterministic processes; however, technique is step-by-step, with results often not fully known beforehand. Zausner (1996) notes how artistic work is very sensitive to stimuli and speaks of the role of the ‘inconsequential’ in art, unpredictable but not random influences.

Near-Periodicity Without Strict Repetition

For something new, repeated jousts may be necessary. Freud noted the similarity of healthy versus unhealthy cycles of change, productive ‘working through’ versus self-defeating ‘repetition.’ Perhaps these represent strange or periodic attractors. Ego psychologists similarly described play as re-creating, aimed at mastery. Some view art as a working through of a psychological, aesthetic,

cultural, or technical problem. Sandra Russ and others comment on the inventiveness of young children's play, and the play-like, restitutive aspects of creativity in adults. Different attractors can illuminate whether play or creative labor solve particular psychological problems or represent neurotic stuckness.

Catastrophic Change and Bifurcating Systems

Bifurcation refers to transformation of a system or attractor into another kind, or a shift to a new regime of behavior (for example periodic to chaotic). Creative phenomena can exhibit near-regularity and then wild fluctuation. Things may be close to periodic in the innovation of normal science. In contrast, qualitative leaps in ideas or artefacts, revolutions and new movements, periods of insight or illumination, broken genres, and shifting paradigms all represent 'catastrophic' transformation. Breakthroughs may be numinous at times, when a creator seems 'possessed' by the work or the work 'creates itself.'

Zausner (1996) writes of creativity comprising subsystems bifurcating into new order. Chaotic systems can also settle back into stable attractor regions. Bifurcations may account for transitions from inspiration through consolidation and then to implementing a creative program, or shifting between riffing and editing, interleaving roles of performers, or how circus emerges from theatre and sport.

Chaos and Complexity in Creativity

Several characteristics of chaos are discernable in creative process and product. Process must avoid stasis, stagnation, premature closure, capture by fixed-point or limit-cycle attractors, and the strictures of a critical or imperious environment. Chaotic systems can demonstrate healthy flexibility, autonomy, and openness to new experiences. Neurologist Walter Freeman III famously wrote, "Chaos provides ... a deterministic 'I don't know' state within which new activity patterns can be generated" (Skarda and Freeman, 1987, p. 171). Frederick D. Abraham has spoken of 'self-organizational bifurcations,' observing that both chaos and instability can facilitate creativity. Late poet laureate Howard Nemerov spoke metaphorically of chaos as the primordial *order* before creation; Ben Goertzel, Ronald A. Finke, and others provide models of chaotic logic and cognition. Theorist and clinician Michael Bütz refers to not-strictly-speaking periodic psychic swings, with structure emerging from such chaotic behavior. The vicissitudes of different creative episodes can be viewed as patterned (phase) portraits of the positions and directions of multiple generative and expressive processes. When near some attractors, work remains within a genre, style, school, theoretical orientation, paradigm, convention, or norm. Style is a region around an attractor in a content-domain phase space (e.g., architecture, writing).

Attractors may also be useful for describing shifting artistic schools, or patterned themes and motifs within a single work or *oeuvre*. These include phenomena such as rhythm, repetition, progression, periods of 'decadence,' rediscovery of old ideas, recapitulation of themes within a work, entrainment and synchrony across different systems, narrative and non-narrative forms, multiple near-simultaneous discoveries, and revolution in the air.

Scaling, Symmetry, and Fractal Properties in Creative Work

Fractal patterns depict the self-similar ordering of trajectories represented around a chaotic strange attractor. Zausner (1996) observes how a person's creative periods appear self-similar, with successive inventiveness and reflectivity; this may parallel the correspondences between alternating mood states (including those in bipolar affective disorders) and creativity. Richards discusses the importance of experiencing and reconciling contradictory moods and mixed states. In addition, works of art – as opposed to reproductions and hack cover versions – are unique; fruits of creative process can have unpredictable or irregular yet not disorderly forms. An artist's different works are also self-similar and have 'family resemblances,' kinships reflecting the processes of their birth.

Fractals are similar (although not identical) at different scales of magnification. Their aesthetic qualities draw us in. People are attracted to waterfalls, beaches, and other things instantiating them. This is related to the draw of little things; Levi-Strauss (1966, p.23) wrote that, "all miniatures seem to have an intrinsic aesthetic quality." Small and complete, miniatures are important in creativity; symbol, song, statistical model, science toy, and mathematical notation are all miniatures. They point us toward scaling up or down, recursion, and fractals themselves. There is also tension between symmetry's sometimes inherent beauty and contrasting roles of imbalance, disequilibrium, intricacy, symmetry-breaking, facilitative entropy increase, and disorder. Creative people tend to prefer Barron-Welsh Art Scale figures that are asymmetrical and complicated. Nonidentical fractal similarity and nested recursive forms (as a play within a play) help reconcile these ideas.

Dissipative Systems: Does Creativity Occur at the Edge of Chaos?

This article discussed how dissipative or far from equilibrium systems can create new order and build structure, even as they accelerate a system's running down. Ruth Richards, Frederick Abraham, and others explore the importance of systems at the edge of chaos to creativity; creative work is dissipative. You can move a system away from equilibrium by increasing its energy temporarily. (Richards calls this 'Turning up the heat' to make multiple creative insights more likely; think of multiple popcorn kernels popping more often.)

Conditions that foster brainstorming may implement cognitive sets or workspace settings that move us somewhere between stasis (or periodic behavior) and (moderate-dimensional) chaos, as Csikszentmihalyi's 'flow' states lie between boredom and anxiety. Zausner (1996) describes artistic products as manifesting order; a work's uniqueness coalesces from dissipative structures. She also comments on potential disorder, with a fine line between 'breakthrough and breakdown.' Creativity and psychopathology

are sometimes close together; David Schuldberg (1994) speaks of both 'giddiness and horror' in the creative process. The edge of chaos also sheds light on transitional or 'liminal' phenomena, psychological or cultural in-between zones important in play, dreaming, interpersonal attachment, and psychotherapy.

Emergence and Self-organization

Zausner (1996) asks instructively, "Doesn't the artist have a plan for the painting?" A new work may be an emergent configuration rather than coming from planned progress toward a pre-imagined point. Creating involves self-organization, related to continually 'self-producing' and 'autopoietic' structures. Musical works, new theories, and novel solutions to coding problems can be viewed as emergent organization. This concept provides a window on how a great deal of new information is revealed, found, produced evaluated, and used by culture.

The Creativity Question as Intractable Itself

This article has discussed two forms of intractability. First, facilitating creativity is difficult. It may even be counterproductive to push for it; some speak of creative work as 'impossible' itself, at least in dry times. Secondly, the study of creativity has long tantalized philosophers, theorists, and researchers. One hint that it may be amenable to NLDS approaches comes from just this difficulty; remember Goldberger's dictum about hard-to-solve problems.

Nonlinear Models in Creativity

An understanding of potential nonlinear creativity models is important for grasping and comprehending, modeling, and fostering creativity.

Nonlinearity

First, where is the nonlinearity? What are relevant non-straight-line relationships? Richards and others have extensively demonstrated 'inverted-U' relationships between creativity and psychopathological characteristics, and this seems to hold for positive and negative affect as well. Simonton, David Harrington, and others also comment on nonlinear relationships among creativity variables.

Fig. 3's model can provide a toy demonstration. (Remember that its nonlinearity comes from the 'hard' nonlinear spring in the middle.) To see this, we can define its horizontal (x) axis as ranging from 'inner focus' on the left to 'outer focus' toward the right. When one block is moved and released, they trace oscillating paths depicting intrapsychic delving, incubation, woodshedding, potential access to 'primary process' material at the left, with environmental immersion, making the work, performance, dissemination, and suffering critical feedback all toward the right. A strange attractor in a phase-space rendition of the motion could signify a region of constrained novelty, spinning ideas converging and diverging without repeating exactly; the system could also settle into repetitive, ho-hum patterning.

Open Systems and Creativity

Creativity is environmentally situated; perception and action function at the interface between organism and environment. External nature, so fractal in itself, has much to teach and inspire. Similarly, the creator engages somewhat, whether personally or not, happily or not, with the physical and social worlds, materials and audience. Engagement, ongoing, embeds proceedings in time.

Evolutionary Epistemology, Emergent Order, and Creative Processing

Evolutionary epistemology studies how new knowledge develops and accumulates, analogously to biological structures' evolution through Darwinian natural selection. Psychologist Donald T. Campbell (1960) presented a useful account of creative cognition, suggesting that creativity starts with a wide variety of ideas attained relatively 'blindly' (although not by mere chance). This initial multiplicity of ideas is analogous to the diverse variety of biological forms in Darwinian evolution, introduced into the genome by random mutation and other factors. Diverse ideas are then evaluated and retained or discarded according to 'quality' or utility; this corresponds to the selection and transmission of heritable biological traits on the basis of their 'fitness.' It is fruitful to pursue Campbell's model further and explore how mutation, selection, and adaptation apply to memes (Dawkins' term, itself one) in creativity, how emergence provides new genotypes, then phenotypes, for selection to act upon.

Complex Systems, Creativity and Evolution

As noted above, dissipative systems can create emergent new order 'for free.' This increasing organization is not just possible but favored with ever-increasing entropy. This holds for the recombinations and expressions of basic genetic mutations, two phenomena involving dissipative biological processes. The products of this morphogenesis are then the raw materials for a next round of selection of both biological structures and ideas; the order coming from the edge of chaos contributes additional variation for evolutionary selection to retain or discard. Effects of individual, granular mutations interact, combine, and unfold in gene expression within the phenotype, and through environmental selection, as well as over lengthier evolutionary history. Emergent

forms amplify how diversity is generated and expand where variability comes from; this includes epigenetic effects, as environmental information alters the expression of genes.

The rich diversity of concrete products, behavior, or ideas is also potentially magnified through the across-time interactions of multiple small variations in ideas. In creative activity, many basic novel items (memes) interact and combine nonlinearly to produce more novelty, an ever vaster variety of forms to select or throw away. The modular, combinatory, and dynamic properties and principals undergirding variation, expression, and selection augment the processes of both biological evolution and creativity.

Sleep and Dreaming

An example of multiple and recursive looping in human evolution and creativity involves sleep and dreaming. Humans spend much more time in REM sleep than any other primate. Neuropsychologist [Matthew Walker \(2017, pp. 75–76\)](#) proposes that increased dreaming was important to the creative leaps in human culture leading to modern *homo sapiens*. He notes primate ancestors nesting in trees spent much less time in REM sleep, perhaps to minimize accidental falls. However, REM sleep is extraordinarily creative. “The second evolutionary contribution that the REM-sleep dreaming state fuels is creativity. ... REM sleep ... takes ... freshly minted memories and begins colliding them with the entire back catalog of your life’s autobiography. ... we can appreciate ... a classic, self-fulfilling positive cycle of evolution. Our shift from tree to ground sleeping instigated an ever more bountiful amount of relative REM sleep” He adds, “from this bounty emerged a steep increase in cognitive creativity, emotional intelligence, and social complexity.”

Techniques to Increase Variability and Foster Creativity

Combinations can be formed in many ways, including: Juxtaposing and mixing distinct or diverse elements, sliding unrelated concepts past each other, examining match, mismatch, blends, and interesting features, noting when contrasts create conceptual connections or conundrums, and discarding unproductive or unpleasing correspondences (part of ‘selective retention’). Superimpositions and combinations can be casual, constructed as non-hierarchical collage, even force-fit. They may display playful, hostile, or destructive, attitudes toward more ‘sensible’ or acceptable agglomerations. They do not strive for superordinate categories or top-down chain of command. They have relationships with more developmentally prior concepts, akin to Piaget’s preoperational thought and Vygotsky’s thinking in complexes, something noted by Richards. Varieties of superimposition, accretion, assemblage, Fabulized Combinations on the Rorschach, apparent synesthesia – these all represent additive and multiplicative combinatory experiences and behaviors. [Rothenberg’s \(1979\)](#) homospatial and Janusian thinking describe such routes to new ideas.

Creative cognition later ‘channelizes’ into ‘creodes,’ evolutionary biologist [C. H. Waddington’s \(1957\)](#) term, deepening valleys in landscapes of developing ideas. Periods of normal science, mature and then stale genres, correspond to valleys. Similar models have been constructed with neural network and other techniques to simulate perception, thinking among people with schizophrenia, interpersonal and psychotherapy process ([Pincus, 2001](#)), leadership and decision-making ([Guastello, 2010](#)), and attitude formation ([Vallacher and Nowak, 1994](#)).

A Dynamical Systems Program for Creativity

Creativity research will benefit from even more consideration of dynamical systems approaches and how they can illuminate originality. New ideas and techniques can help, based on theoretical and empirical models that include time as a variable and contain curvilinear relationships or interacting variables. How does a ‘remote associate’ on Mednick’s test emerge or converge? What is the trajectory of an artistic career? What are transitions from incubating to elaborating, from boredom or anxiety to ‘Flow?’ How does a ‘creative crisis’ resolve, or not? How to do the impossible and make art?

Recent research shows that – for very complicated problems (such as optimizing with many, many constraints) – inattentive, background, off-line, non-focal, parallelized computation (and ‘sleeping on it’) serve extremely well. Nevertheless, a creative adult’s improvised or indirect approaches to new problems represent incremental strategies, practical wisdom but not theory. Real things vary too much for relentlessly complete on-line processing or exhaustive categorization.

This speaks to the key role of distributed, peripheral, and low-level (versus executive and top-down) processing, and the use of heuristics, inexact procedures without guaranteed results that are often extremely useful and efficient. We would often best engage in ‘satisficing,’ instead of ‘optimizing’ or ‘maximizing’ (Herbert Simon). New understandings come in approximations and increments rather than dropping, guaranteed, from formulas. We can provide guidelines and procedures for creative brainstorming, but not a cookbook for ideas themselves. Indeed, if we found such a cookbook we might not call its results creative; this issue is coming up in current discussions of whether algorithms derived using Artificial Intelligence (AI) can be creative.

Making sense of our own lives, planning, steering, and ‘rational choice’ are all approximate, sometimes irrelevant, and they contain blind spots. Living as we do through everyday language, we use incomplete but handy views of the world, innumerable daily instances of Richards’ (2017) *Everyday Creativity*. Heuristics have nonlinear effects and interactions, and we can only see their results after the fact. Thus, our attainments are not easily decomposable into components, and we can’t play them backwards. [Tobi Zausner \(1996\)](#) comments on the irreversibility of painting, situating it outside of Piagetian formal operations and squarely as a dissipative system. Because chaos is involved, even SCS produce complex outputs. We inhabit big ideas, often gracefully, and grapple with existential concerns; life’s practical crafts are humble and hands-on, productively using ‘simple rules.’ This does put limit on social engineering and thankfully prohibits a truly totalizing fix on the good life.

Yet, this does not limit what is possible in everyday life. Our human and natural world is determined yet unpredictable, complex and varying but also organized, changeable and sometimes shocking. It is self-similar day to day, and sometimes very beautiful. We must sideline perfection to embrace and create the rough-cut splendor and daily miniatures of our local worlds.

At the same time, climate change presents macro, complex systems problems that require creative solutions for the survival of our nonlinear and dynamic ecosystem, and quickly too. We are upon urgent times; what can we learn from the extinctions of the past? As we act locally, create and improvise we must, with an eye on the big picture, quickly and carefully.

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- http://www.ideasthatmatter.com/quarterly/itm-1-4/itm_1-4.pdf – Download article (pdf) by Sally Goerner: *Living on the Edge: The Evolution of Integral Society*.
- <https://www.complexityexplorer.org/> – Complexity Explorer (Melanie Mitchell's MOOC).
- <https://ccl.northwestern.edu/netlogo/> – NetLogo Site.
- <http://deepeco.ucsd.edu/sugihara/> – George Sugihara's Deep Ecology web site.
- <https://www.youtube.com/watch?v=QQwtrWBwXQg> – Demonstration of reconstructing an attractor from data (Sugihara).

Nonprofit Creativity: Essential for a Healthy Sector

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Introduction

The assortment of organizations that serve society, providing services that empower the disadvantaged or provide charitable assistance, are important societal institutions. However, countries around the world offer different terminology to define the work of organizations established for public benefit.

The term, Non-governmental Organization (NGO) is a ubiquitous term that refers to local, national, or international organizations or associations that reside outside the business and political realms. The definition was initially established in the United Nations Charter and refers to organizations that may be consulted by the UN as it proceeds with its operations. The term, International Non-governmental Organization (INGO) is also popular and refers to the various groups that have organized to pursue goals that transcend national boundaries (Boli, 2006). Amnesty International, Oxfam, Human Rights Watch, Médecins sans Frontières (Doctors without Borders), Save the Children International, and CARE International all represent INGOs.

Public Benefit Organizations, commonly described as charities, provide support for relief of poverty, caring for the sick, and promote other public benefit endeavors. Such organizations are similar to NGOs and INGOs because they come from the same tradition of philanthropy. History records that the era of European Enlightenment included the establishment of philanthropic organizations that transformed society. Even earlier, religious organizations supported benevolent actions. Accounts of philanthropic organizations also date back to 13th century China (Davies, 2013).

In the United States, organizations that provide public benefit are generally referred to as nonprofits. While US organizations share some of the attributes of the Public Benefit Organizations in other countries, the nonprofit sector in the United States has some distinguishing features.

US Nonprofit Sector

When considering the United States economy, it is important to understand the three sectors that impact the health of the nation. Each plays an integral role in contributing to a vigorous and vibrant society.

The Public or State Sector refers to federal, state, and local governments. These entities have the authority to pass legislation to support the general welfare of citizens. Government is largely funded by a variety of taxes and fees that are paid by citizens and other tax-paying organizations.

The Business or For-profit Sector is made up of organizations and individuals that run profit-making ventures that are only partially subject to public sector control. The private sector generates profits from operations, and these profits fund the Public Sector through taxes.

The third division of the economy is termed the Nonprofit Sector. A variety of organizations—including public charities and foundations—are part of this sector that is unique in its mandate to provide public benefit through mission-based efforts. Recognizing that the nonprofit sector is not as well-known or understood as its mightier cousins, it is important to be familiar with how this sector operates and why its health is essential to the US economy.

Nonprofit organizations provide programs and services that support a self-defined mission. An organization's mission represents its public responsibility to improve society through implemented programs and other activities. While these organizations must demonstrate fiscal prudence in operations, they are not driven by a profit motive that is customarily apparent in the for-profit sector. Rather the mission represents the nonprofit's overarching goal. This means that the nonprofit sector strives to accomplish a double bottom line where success is measured by both financial and mission effectiveness.

Additionally, while nonprofits are known as businesses with public missions, they are funded in distinctive ways. Individual, foundation, and corporate donations are common funding mechanisms. Nonprofits also receive grants and contracts from government agencies and proceeds from the sale of goods and services to their clients and others.

Another characteristic of the sector is that public charities in the US are exempt from many taxes. They generally don't pay income tax, and, in some cases, they are exempt from property, sales, and value-added taxes. This means that governmental agencies forego tax revenue to promote nonprofit operations. Another unique feature of the nonprofit sector is that individuals and organizations that make donations to qualified nonprofits generally receive tax relief for those donations.

The size of the US nonprofit sector is most often measured in terms of donations that come from individuals, foundations, and corporations. In 2017, donations exceeded \$400 billion ([Giving USA 2018](#)). Another measure of size considers the number of organizations that are classified as nonprofits. In 2013, the IRS had registered a total of 1.41 million nonprofits ([McKeever, 2018](#)).

Nonprofits are an important contributor to the economy. In fact, eighty-six percent of wealthy donors have confidence in nonprofits to solve social problems—more confidence than in the federal government or other public sector participants ([U.S. Trust, 2018](#)).

The Three-Failures Theory emphasizes the interrelated structure of the US economy. The theory, described by [Steinberg \(2006\)](#), explains how the three sectors (Government, For-profit, Nonprofit) respond to failures to deliver appropriate services to applicable constituencies within society. The three sectors constitute a circle where each member responds to the contract failures of its neighbors. When failure to provide adequate quality and quantity of services occurs, one of the other sectors steps in to provide the required assistance ([Steinberg, 2006](#)).

For example, educational institutions (nonprofits) need computers for instructional purposes. However, not all schools have funds to buy computers from the for-profit sector. When this happens, either government steps in to provide computers to schools, or for-profits arrange to donate the necessary equipment. Another example is when nonprofits give meals and groceries to individuals to provide necessary additional food to augment the government's Supplemental Nutrition Assistance Program. Also, many nonprofits devote their time to missions that involve environmental agendas—stepping in to protect the environment where government and for-profit organizations have failed. More recently, for-profits have been investigating developing private insurance alternatives for their employees because they view government alternatives as both inadequate and expensive.

The interrelatedness of the three structures signifies that all sectors play noteworthy roles in creating a successful society. While government and business sectors are recognized for their important roles, the nonprofit sector also contributes much to society, which would be significantly less effective, caring, and vibrant without it.

Program success enhances mission accomplishment in the Nonprofit Sector. Programs may be varied based on the nonprofit mission, but whether a nonprofit provides social services to its clients, conducts research to find cures for diseases, or encourages voter registration, the programs provided must be effective. Additionally, funding mechanisms in the nonprofit sector are inherently unstable because individuals, government, and industry can change giving priorities which reduces the sector's collective ability to operate cost-effectively and accomplish respective missions. Therefore, with survival at stake, nonprofit leaders must recognize that to ensure success, they must develop creative programs to support mission achievement and put in place innovative fundraising mechanisms to finance their operations.

The economies of other countries don't necessarily have the same interrelatedness as seen in the US. In some cases, Public Benefit Organizations are largely funded by government, making solicitation of individual donors and corporations nonessential. Different organizational structure and tax laws also make the US model distinctive. However, all Public Benefit Organizations around the world can benefit from creativity. The following section applies equally to US nonprofits, Non-governmental Organizations, and International Non-governmental Organizations. Creativity transcends national boundaries and innovative outcomes are essential to improve circumstances around the world.

Creativity in Nonprofit Programs

Nonprofit programs use many strategies and processes that are familiar to researchers in creativity. Following are examples of creative programs that demonstrate impact and can be associated with specific creative approaches. The examples have been grouped by creative strategy.

Combining Disparate Ideas

This strategy involves looking for relatedness in ideas that seem unrelated. In general terms, the strategy involves combining alternate perspectives that can provoke novel connections between ideas that come from different fields—something that can be described as having an unexpected twist ([McCaffrey, 2012](#)).

Jim Fruchterman knows how to use alternative perspectives to enhance creativity. He is the founder of Benetech, a Silicon Valley nonprofit. He is also a MacArthur Fellow—one of the individuals awarded the prestigious MacArthur Foundation award for creativity. Since 1989 Benetech has been developing and providing software to help other nonprofits creatively meet societal needs. In an early project, Benetech demonstrated the power of combining disparate ideas.

Fruchterman wanted to solve a problem for individuals who have difficulties making use of printed books. This group of individuals who may have visual impairments, a variety of learning disabilities, or limited mobility are not able to use printed material in the traditional way. As he considered the problem, Fruchterman recalled that in one of his most exciting engineering classes at Caltech he learned how to design technology that would allow a computer to distinguish various sorts of military targets (e.g., different types of military tanks). The weapons systems in his class project could direct munitions to strike specific targets. Considering his goals to provide access to books for those with disabilities, Fruchterman recognized the parallels in the unrelated projects. He reasoned that if computers could distinguish between military targets, they could also distinguish the shapes of letters (Benetech, 2019).

Using the same basic technology, Fruchterman developed a reading machine that used the tank-targeting technology. Despite the obvious differences (in size, shape, and purpose) between military tanks and letters, Fruchterman was able to understand that the same computer technology could solve both problems. By seeing the relationship between the two problems, he was able to envision new uses for the tank-targeting technology. Fruchterman went on to create Bookshare, a library of textbooks, bestsellers, and children's books. In this novel version of a library, books are read to individuals who cannot utilize traditional paper editions (Hennesy, 2017).

Another group of nonprofits knows how to combine ideas to make a difference in the lives of seniors in San Diego County California. North County Senior Connections in conjunction with Dreams for Change, Interfaith Community Services, the Jacobs & Cushman San Diego Food Bank, and funded by the Rancho Santa Fe Foundation incorporate two important aspects of healthy senior living—nutrition and socialization (Rancho Santa Fe Foundation, 2019).

The collaborating nonprofits serve the dual needs of low-income seniors in San Diego County with both healthy meals and important opportunities to socialize. The nonprofit collaboration distributes freshly prepared meals from a mobile food truck, appropriately named Thyme Together. To augment the food service, community members provide lunch time activities that inform and entertain the seniors (Rancho Santa Fe Foundation, 2019).

This mobile collaborative of nonprofits succeeds in a number of ways. Not only do participating seniors choose from a full menu of nutritious lunch options, they also can pay for their economically priced meals (generally \$2 a meal) with CalFresh benefits. CalFresh is the local supplemental nutrition assistance program. Furthermore, the efforts of the collaborating nonprofits provide a mobile senior center that meets the seniors in their communities, allowing them the opportunity to enjoy social interaction.

Big Picture Thinking

Another creative way to confront a problem is to consider the larger context in which a challenge is contained. This strategy involves taking a metaphorical step back to better understand the parameters and background of a situation. Insights from this change of perspective can provide novel answers to a problem (Sternberg, 2006).

In 2009, Dr. Teresa Smith founded the nonprofit, Dreams for Change, to meet the needs of individuals and families who had been adversely affected by the financial downturn. Dr. Smith and her colleagues from San Diego State University's School of Social Work and California Western Law School collaborated to produce a novel solution based on stepping back to consider the big picture surrounding homelessness. Recognizing that homelessness is a complex issue, the group decided to concentrate on one part of the problem. They considered the situation where individuals or families had been forced to leave home and seek permanent shelter in their vehicles. When this happens, not only does the vehicle provide transportation to work for adults and school for their children, but also the car is used for nighttime accommodation. Often its last and most valuable asset, these vehicles represent a family's bridge between poverty and homelessness (Dreams for Change, 2019).

Dreams for Change created The Safe Parking Program to provide safety and some stability for those living in their vehicles. Clients are welcomed nightly at one of two safe sites. Staffed by case managers and volunteers, the program can accommodate seventy families each evening. In addition, the nonprofit provides transitional services to help clients find permanent housing, employment, training, and emergency support to stabilize their circumstances. These services have the goal of not only stopping the slide into homelessness, but also helping participants gain skills and income that will lead to self-reliance (Dreams for Change, 2019).

By understanding the needs of those who must sleep in their cars, Dreams for Change has been able to keep individuals and families safe and prevent a further decline in their economic stability. The organization provides its struggling clients with an innovative strategy—a secure home in a car until other options are found. This pioneering program creatively supports its clients and helps them maintain their independence. This example of program creativity supports the clients of Dreams for Change and effectively addresses one aspect of homelessness.

Doniece Sandoval, founder and CEO of nonprofit Lava Mae, also provides an example of how big picture thinking can contribute to solving specific social issues. Lava Mae addressed the fact that those who are homeless do not have access to hygiene alternatives. Without ways to keep clean, the homeless have no way to change their situations because a lack of hygiene makes finding a job or even social interaction with others a major obstacle. A lack of hygiene not only contributes to homelessness, but also adversely impacts human dignity. To address this problem, Sandoval created opportunities for those without resources

to access showers and toilets by repurposing retired transportation buses to serve as mobile shower units. These units were connected to fire hydrants. More recently commercial shower units have been employed ([Hughes, 2017](#)).

Lava Mae augmented shower and toilet services with pop-up care villages that provide medical and dental services. Bringing the services to the people where they congregate has helped promote what Sandoval calls radical hospitality—the notion that how you provide a service can be just as important as the service itself. Sandoval founded Lava Mae in 2013 and since then has served more than 15,000 individuals. Delivery of similar services has expanded to Los Angeles and Oakland ([Lava Mae, 2019](#)).

Recognizing the importance of hygiene and acting to provide alternatives for those who are without ways to keep clean represents a big picture understanding of homelessness—one of the most intractable problems that society faces. Lava Mae's response to the challenge represents an innovative way to ease the problem.

Rejecting Inadequate Paradigms

Paradigms—concepts and theories that inform various fields of endeavor—provide structure and substance within most disciplines. Moreover, paradigms specify standards for what approaches and methodologies are considered legitimate when contributions are made to a field. However, assumptions that inform paradigms can become outmoded or in other ways insufficient to support and bound a field. When this occurs, original perspectives and assumptions may need to be replaced by creative alternatives that can expand insights. Fortunately, Dr. Victoria Hale, a recipient of the MacArthur Foundation creativity award, was not willing to accept for-profit sector paradigms that recognize a limited number of business models in the economy. Her efforts provide a good example of how creativity can impact paradigms.

Dr. Hale received a PhD in pharmaceutical chemistry and is a social entrepreneur in the pharmaceutical industry where she develops new drugs and medical solutions. As Dr. Hale considered how she could help the poorest of the world get the medical attention that they require and deserve, she recognized that the for-profit model that generally requires a solitary pursuit of profit was simply not an effective way to approach the problem. As a result, she created a nonprofit pharmaceutical organization ([Hennessy, 2017](#)).

Over time, Dr. Hale realized that this nonprofit model could not support all of her ambitious goals. While it was sufficient to financially support nonprofit research and the creation of drugs, it did not allow the organization to actually serve patients. Acknowledging the shortcomings of the nonprofit model, Dr. Hale began her search for a new hybrid business model that would help her achieve all of her goals ([Hennessy, 2017](#)).

Dr. Hale solved her business problem by partnering with a well-respected for-profit business that licensed her medical products for sale in the lucrative US market. Her organization receives a royalty payment that supports further drug research and allows her organization to distribute the medical devices to poorer patients around the world ([Hennessy, 2017](#)).

Creating a hybrid organization takes advantage of aspects of both the nonprofit and for-profit sectors. Dr. Hale has creatively bridged the sectors to establish an organization that supports her mission and provides ongoing funding for drug development. In rejecting traditional business models, she established an alternate business paradigm that creatively and effectively serves her social goals.

Another creative entrepreneur disrupted a paradigm associated with hospital eateries. Hospitals are not known for their culinary expertise and while patients have to eat hospital food, generally few visitors willingly dine in hospital cafeterias. Helen Doherty, recognizing this paradigm, decided to create another standard for hospital diners. In her role as Director of Dietetics, Doherty eschewed the low bar goal of edible food and created a different dining experience at Massachusetts General Hospital in Boston ([Ross, 2002](#)).

Doherty's goal was to create food service outlets that were so superior that they would bring non-patients to the hospital for meals. Her efforts were rewarded. She received the 1999 Restaurateur of the Year award from the Massachusetts Restaurant Association. Doherty was the first woman and Massachusetts General Hospital was the first institution to receive the award. In April of 1999 the cafeteria and other hospital outlets were preparing and serving food for about 900 patients and 13,000 non-patients daily ([Ross, 2002](#)).

While Doherty's culinary goals improved the overall dining alternatives for hospital patients, staff, and visitors, she also helped a specific patient population. Massachusetts General Hospital is associated with the Dana-Farber Cancer Institute. Doherty created a special café for cancer patients being treated at the hospital. Knowing that the effects of some cancer treatments can suppress appetite, she designed a special menu of small portions that were healthy and appealing for customers ([Ross, 2002](#)).

In rejecting the conventional wisdom that hospital food is customarily unappetizing, Doherty transformed a model in a common industry, creating a new standard for food service. She demonstrated that new paradigms can eclipse outdated standards when an individual activates creativity and sets higher expectations.

Creativity in Nonprofit Funding

The second area where nonprofits require creative strategies is in fundraising. While there are traditional ways of raising funds that have endured and are likely to exist going forward, nonprofits have the opportunity to consider creative fundraising alternatives that can attract donors who seek a newer approach to supporting organizational missions. Matching donors with their preferred giving

strategy can increase donations and inspire allegiance to a cause. As creative alternatives become available, nonprofits need to take advantage of opportunities to participate in these innovative options.

Social Finance

Several new funding alternatives are available to donors. The overarching name for these creative strategies is called Social Finance (Shah and Costa, 2013). Under this umbrella of strategies are new methods of grant-making that favor social innovation and public-private partnerships. Also described as social impact bonds or, more generally, pay for success contracts, they represent novel ways to tap the capital markets for nonprofit funding.

In general, innovation funds address the shortcomings of traditional government grants that often provide funds for only a limited time—a year or two and are not renewable (Shah and Costa, 2013). In particular, The Social Innovation Fund, created in 2009, takes a longer-term approach and adds an element of entrepreneurship to the process. It seeks strong organizations that have experience finding and funding social services nonprofits. These intermediaries assess individual nonprofits, choosing the most innovative programs in which to invest federal funds. Grants are made in larger amounts and are available for up to five years. Furthermore, the federal funds are leveraged because intermediaries are expected to match the federal grants with equal dollar contributions from non-governmental sources.

There is a three-fold benefit to these creative funding programs. The intermediaries are skilled at finding the most innovative programs available within the nonprofit sector. Also, by carefully monitoring the programs, the intermediaries observe program progress and are able to provide additional funds over time for scaling those programs that are most successful. Finally, the requirement to contribute private philanthropic dollars in addition to public funds provides leverage and increases the amounts available to support nonprofit programs.

Nonprofits can seek another innovative source of funds from investors. Dubbed Pay for Success funding, these innovative contracts are also called Social Impact Bonds (SIB). Shah and Costa (2013) noted that these instruments are not actually securities in the traditional sense but are innovative financial agreements that require public sector money to be paid to investors if agreed upon outcomes are met. Thus, government money does not flow to failed projects. This fact turns traditional government funding on its head—no risk of failed projects and payment only in circumstances deemed to be successful. Palandjian (2017) summarized the innovative nature of SIBs as a transfer of risk from the public sector to the private sector.

The players in this model are investors, independent evaluators, nonprofit service providers, and government officials. The investors pledge to achieve a particular goal and agree that the government is not responsible for payment unless an independent evaluator confirms that the goals of the contract have been achieved by the nonprofit service provider. If independent evaluators certify that goals have been achieved, only then do government officials transfer funds to investors (principal amounts plus an additional amount of money to compensate for the risk taken by the investors) (Shah and Costa, 2013).

The first Social Impact Bond project was conducted at Peterborough Prison in the United Kingdom. The goal of the project was to reduce recidivism in prisoners that had been incarcerated for less than a year. The project began in 2010 and final assessment of the venture occurred in 2017. The project assessment calculated that the average reduction in reoffending was 9% in the two cohorts involved in the study. Baseline improvement in the SIB contract required a 7.5% improvement so the result of 9% triggered a payment for investors (Anders and Dorsett, 2017).

Success in various projects funded by Social Impact Bonds continues to be assessed. However, as Costa and Tomasko (2014) pointed out, the contracts are complex. They require cooperation between government agencies, nonprofits, investors, and intermediaries. The cooperative nature of the contracts represents an innovative approach that signals that collaboration is an important practice in such situations.

This Pay for Success model has also taken hold in the United States. There are 17 projects underway that involve \$200 M in capital (Palandjian, 2017). It is likely that this innovative structure of financing will expand and evolve as organizations continue to innovate.

Tax Credit for Corporations and Individuals that Fund Education Initiatives

Another innovative collaboration has been created in the state of Georgia where individuals or corporations may claim a dollar-for-dollar tax credit on their state income tax returns in exchange for a donation to the Innovation Fund Foundation (Georgia's Innovation Fund, 2019). In this arrangement, the Innovation Fund Foundation serves as a nonprofit intermediary that controls the funds collected and uses the funds to provide grants to public schools in the state. The focus is on providing funds to improve student achievement. Priority is given to serving schools with low performance ratings (Georgia's Innovation Fund, 2019).

This state initiative represents a partnership that invites individuals and corporations to join forces in a particular poverty-fighting initiative. The state is providing an exceptional opportunity for donors to receive a tax credit that goes beyond the customary tax deduction of a typical donation. Moreover, the state is only offering this opportunity for donations to an educational fund—prioritizing this sector over others. The state of Georgia's initiative is timely as data from the 2018 U.S. Trust Study of High Net Worth Philanthropy reported that the percentage of high net worth households in the United States that donate to educational charities (K-12) has declined from 33% in 2015 to 24% in 2017 (U.S. Trust, 2018).

Abundance Mentality Leads to Collaborative Fundraising Efforts

Conventional wisdom in the nonprofit sector contends that active donor and potential donor contacts should be carefully guarded and not disclosed to other nonprofits that share the same mission. The logic is that the potential for donations is limited and sharing information is likely to reduce the possibility of gaining a share of potential funding. Believing that the fundraising pie is limited leads to the conclusion that one nonprofit's gain means a loss for another. Like much conventional wisdom—so called wisdom that is accepted as fact and not scrutinized for veracity—this zero-sum logic should be questioned.

Choksi-Chugh (2018), Executive Director of nonprofit San Francisco Baykeeper, believes the nonprofit fundraising pie can expand. She collaborated with multiple nonprofits concerned with preventing and reducing environmental destruction in San Francisco Bay to test the idea. The nonprofits planned a unique on-the-water fundraiser and each invited donors and potential donors to attend the joint event. Following the event, a case study, prepared jointly by the participating nonprofits, was presented to potential donors. Funders were invited to participate in a joint project developed by the collaborating nonprofits or to invest in various parts of the project. Funders shared their appreciation for the collaborative approach and to date one new grant has been received by San Francisco Baykeeper and an additional funder has increased support. Other partners in the collaborative effort also received new grants. One funder even provided a grant to be shared equally by the collaborative (Choksi-Chugh, 2019).

More important than the actual monetary gift, the nonprofit sector now has evidence that collaboration between like nonprofits can benefit the sector. Rather than accept the conventional wisdom that the nonprofit sector operates in an environment of scarcity, there is now a growing sense that collaboration represents a new and creative way to operate and is a step towards eliminating the silos so often present in the nonprofit sector.

Commercial Earned Income Opportunities

Donations and grants are traditional fund sources for nonprofits. However, many nonprofits participate in earned income opportunities because such operations offer alternative funding that many deem more predictable than a revenue stream based entirely on donations. The idea is that mixed revenue streams provide a more predictable income for nonprofit organizations and prevent the potential of a starvation cycle of donations only. Therefore, organizations that manage earned income opportunities are considered more sustainable.

Some nonprofits consider commercial earned income opportunities to be a new strategy for gaining operational funds. However, nonprofits have been participating in earned income opportunities for decades. For instance, the ubiquitous gift store through which a visitor must exit most museums represents an example of attempts to generate earned income for the nonprofit organization.

Most often side ventures are intentionally created to align with the organizational mission. In the case of the museums, the products sold in the store generally relate to the educational mission of the museum. Nonprofits choose this approach to make sure that proceeds remain tax-free to the organization. As long as a nonprofit's income is considered to be related to its mission or exempt purpose, the IRS will not tax the proceeds (Gries, 2017). The IRS specifies additional exceptions for volunteer operated endeavors and those run for the convenience of staff, members, patients, or students (Chan, 2011).

For decades the Girl Scouts have successfully related their activities selling cookies to their mission of promoting leadership and business education (Hawthorne, 2018). Nonprofits could consider emulating the Girl Scouts by identifying and creating opportunities that represent additional income. Such innovative ideas could help nonprofits become more sustainable while staying within IRS guidelines.

Foundations have taken even more audacious steps by designing investment strategies that provide lucrative returns to augment their traditional funding streams. For instance, acting more like venture capitalists, some large foundations, rather than making grants to nonprofits, are investing in for-profit start-ups and even publicly traded companies hoping to provide game changing answers and revolutionary treatments for diseases (Wieczner, 2015). The Cystic Fibrosis Foundation's investment in a for-profit company resulted in both an advancement in disease treatment and also royalty rights to the drugs created. Moreover, the Bill and Melinda Gates Foundation has regularly increased its program funding through investment. Key is making sure that the IRS regards the returns on the investments in the same way that charitable donations are viewed. As large foundations introduce creative approaches to mission accomplishment, it is likely that such additional opportunities will positively impact and stabilize sector revenues.

Crowdfunding

Another development that supports nonprofits is the concept of crowdfunding. Crowdfunding is a generic term that represents the efforts of individuals and organizations to raise revenue from a large number of people over the Internet. The earliest crowdfunding schemes involved raising money to fund a project or venture in the for-profit sector. The funds received through Internet portals serve as an alternate form of finance for these enterprises, giving them access to capital and increasing the pool of investors. Venture capital and debt funding options are both available.

Similar to the for-profit model, nonprofit crowdfunding requires contracting with a fundraising platform on the Internet to provide opportunities for individuals to donate money to specific activities. Mirroring efforts in the for-profit sector, nonprofits

are using the same strategies and social media platforms to promote their specific programs or causes. Like other fundraising approaches, crowdfunding depends on an emotional appeal to potential donors.

The creativity of crowdfunding is two-fold. It uses social media to tap a large number of potential donors who are contacted through various online platforms and are connected to donation portals. Campaigns can go viral and attract donations from multiple diverse online communities—many that may not have previously been aware of the specific nonprofit or its mission. In addition, the ease with which donations can be made adds to the success of the platform.

The bottom line is that social media has taken hold and funding for nonprofit projects on the Internet is here to stay. Additionally, technology advances are likely to increase the number of creative alternatives that are available, so nonprofits need to be ready to take advantage of new opportunities.

Due to differences in legal systems, tax laws, and even societal norms, the fundraising strategies described in this section may not be licit or even feasible in all countries. However, innovative strategies such as social finance are likely to become worldwide standards in the future. Tax incentives and earned income requirements in individual countries also vary so it is important to consult local tax laws before trying to mirror these strategies. However, the concept of abundance transcends borders and crowdfunding is already employed internationally.

Conclusion

Organizations created for public benefit are called by various names around the world. However, no matter what name is customary, these organizations provide important structure to civil society and are pivotal in constructing solutions to intractable problems that occur locally or span international boundaries. In particular, the nonprofit sector is pivotal to the economic strength of the United States. Not only is the sector large and growing larger, the missions that the sector fulfills are of increasing importance. The nonprofit sector will continue to provide needed services to clients, and nonprofit missions will continue to help society fulfill its contract with its citizens. Keeping the sector healthy is of utmost importance.

One of the ways to promote a healthy and vibrant nonprofit sector around the world is to encourage talented leaders in the sector to express their creativity. Leaders who are trained to look for creative strategies must introduce innovative concepts and initiatives that can be integrated into the daily operation of public benefit organizations. In particular, developing creative programs that answer client needs and provide overall impactful service are required. Furthermore, these programs must be characterized not only by innovative design, but also innovative delivery.

Creative funding mechanisms must also be evaluated and incorporated so that the sector can be funded. Nonprofits need to minimize their time fundraising so that they can concentrate on mission achievement. Fundraising needs to be a means to an end, not an end in itself.

Since creativity can be activated and developed using multiple strategies and processes, the goal of nonprofit leaders should be to promote creativity in all organizational processes. Any organization with a social mission should consider engaging in ongoing dialogues about creativity to be sure that creativity is valued. Moreover, leaders need to understand that a free-flowing dialogue about creativity can translate into specific outcomes and encourage a cycle of creativity that can boost the overall impact of a specific organization. However, key to this creativity movement is leadership. Public Benefit Organizations around the world need to employ individuals who value creativity and demonstrate a commitment to introducing and supporting innovative approaches in all facets of an organization. While journeyman employees who are reliable and competent are needed in the sector to implement creative agendas, only creative visionaries can lead this important sector to greater achievement.

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Novels

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Glossary

Coherence The quality of being logical and consistent, of forming a unified whole. Usually based on a linear pattern, narrative coherence is necessary to fiction writing but not to all forms of creative writing.

Fiction In narrative literature, fiction refers to a form of prose that describes or reveals imaginary events and people. Fiction is a delivery system of meaning and should not be confused with the notion of falsehood or the conversational juxtaposition of fact versus fiction.

Implied author What the reader infers about the author from how a piece of fiction is written. Distinct from the writer and narrator, the implied author (the authorial character) is a construct, or mask, that corresponds only in degrees to the human writer's intentions, personality, beliefs, etc.

Narrative In fiction writing, the sequence in which the story and plot are revealed.

Narrative tense The grammatical tense of the text. Though present tense (do, say) is used effectively in many novels, the most common and traditional tense is the past tense (did, said), in which the story and events of the plot occurred at some time prior to the narrative delivery.

Narrative voicing The perspective or viewpoint (or mode) of the narrator's presentation, usually written in third-person (he/she) or first-person (I). Historically, the most commonly used mode in fiction is the third-person omniscient perspective, giving the narrator an overarching point of view.

Narrator The conveyor of the narration, typically in its entirety. The narrator may be an anonymous, non-personal, or stand-alone entity, or appear as a character within the story.

Plot A chain of cause-and-effect relationships, creating a pattern of unified action and behavior.

Prose Language patterns that are consistent with natural grammatical structures and flows of natural speech. Prose is one of the three original verbal arts categories (poetry, drama, prose) of Ancient Greece.

Story A chronicle of events that requires entities or agents to drive the events, otherwise the chronicle is not a story but a sequence of occurrences (not synonymous with narrative or plot).

Verbal art The three verbal arts categories of Ancient Greece were poetry, drama, and prose. Today, verbal art typically refers to creative writing intended for publication, which includes poems, stage plays, screenplays, short stories, and novels.

Novels as Creative Products

Novels have been a topic of modern academic discourse for over four centuries. In this discourse, the generic label of *the novel* typically refers to the product that emerged out of early modern Europe. However, long-form fiction and the literary object that became the modern novel, along with literary criticism and literacy itself, have origins in antiquity. These forms spread across time and across cultures to influence the numerous variations that constitute the novel of the contemporary marketplace. Novels are now written in every major language, the most popular of which are translated for international distribution.

In a recent treatment, *Il Romanzo (The Novel)*—a five-volume collection totaling 4,000 pages published originally in Italian—over 200 voices approached the topic from the latest perspectives regarding history, culture, philosophy, structure, and theme. In the introduction to the two-volume English edition, editor Moretti (2006) proclaimed that the novel was perhaps the first truly global literary product. “The novel is commodity and artwork at once: a major economic investment and an ambitious aesthetic form” (p. ix).

This encyclopedia entry concentrates on novels as historically evolving creative products and what these products reveal about creative writing. Novels can be understood from numerous perspectives, including the ways readers interpret and writers construct. Though multiple views are integral to generating insight, a recurring obstruction is the tendency for normative descriptors such as “the reader,” “the novelist,” and “the writing process.” As the literature from every discipline demonstrates, the only consensus about these singular descriptors is that little consensus exists. There is no reader but readers, no writer but writers, no writing process but processes. Each is complex, varying, and often idiosyncratic, and each influences the eventual creative product, in this case the novel (see Kaufman and Kaufman, 2009, for an overview of research on the psychology of creative writing). External factors such as literacy, culture, and information technologies (to name a few) play critical roles in determining (i) who in history becomes a novelist (and eminently successful), (ii) what writing processes these novelists employ, and (iii) who reads novels and what kinds of reactions these readers have.

In a systems model approach that Csikszentmihalyi (1996) laid out in the opening pages of *Creativity*, “creativity does not happen inside people’s heads, but in an interaction between a person’s thoughts and sociocultural context” (p. 23), where “an idea or product that deserves the label ‘creative’ arises from a synergy of many sources” (p. 1). This model applies to creativity with a capital C, the kind that turns around and influences the culture from which it takes its cues (i.e., eminent and professional artistic creativity that motivates a novelist to write and publish). The three main aspects of this systemic view are: (i) the domain, which consists of the symbolic rules and procedures for the particular creative endeavor; (ii) the individual creator, who works alone or part of a creative group; and (iii) the field, which houses the gatekeepers of the domain. In the parlance of novel writing, the domain is the novel, the individual creator is the novelist, and the field includes the fiction publishing industry and critical readers.

Historical Production

What do novels reveal about creativity in history, about the evolution of creative products, processes, and people, and about domains, fields, and individual creators? In an aesthetic treatment, Lamarque (2003) drew an important distinction between fiction and literature, in that not all fictional work is literary, and not all literary work is fictional. As a creative product and a work of representational art, the novel is as much the result of technological innovation as of cultural drift and diffusion. While characteristics of novels (themes, metaphors, character arcs, etc.) have become as recognizable today as the characteristics of a sculpture or concerto, the particulars are forever evolving and adapting. As Thomas Pavel detailed in *The Lives of the Novel* (2013), long-form narrative fiction is a historical development—a domain-specific type of writing that evolved into what is recognized today as the contemporary novel.

Product Evolution

The novel’s emergence was not haphazard but, like other art forms, dependent on preliminary conditions. The three conditions that needed to occur simultaneously, conditions which remain relevant today, are:

1. public literacy;
2. leisure time and the freedom to read; and
3. widespread reproduction and circulation of written materials.

The first of these two, literacy and freedom, have occurred in multiple societies at different stages in history. For the product now recognized as the modern novel, the third requirement was specific to one occurrence in history: the moveable-type printing press. Today, this third criterion manifests as both print and electronic delivery systems. Despite the secure place of the novel in the contemporary verbal arts, its success is still dependent on the same three conditions. Current societies lacking public literacy, the freedom to read, or the ability to produce or distribute written material also tend to foster comparatively few fiction readers and few if any novelists.

Public Literacy

Evidence indicates that nearly every preliterate society engages in some form of basic narrative practice, in which the human brain works as a kind of meaning-making organ that utilizes narrative cohesion. However, the novel constitutes a higher-level narrative object, the birth of which is specific to the relatively recent emergence of literacy. In an anthropological review, [Goody \(2006\)](#) argued that literacy itself led to long-form narrative construction and coherence, which changed the way that societies and individuals produced and organized meaning. Oral recitation and analogy have been basic forms of storytelling for millennia, but epic narrations (i.e., stories with long metrical runs) require writing. The invention of writing allowed for longer constructions of thought, which in turn placed more importance on time and linear coherence (i.e., a beginning, a middle, and an end), elements often absent from folklore and myth.

As understood from neuroscience, the human brain is not a linear recorder but perceives and stores information in fragments. These fragments get stitched into coherent mental objects such as memories, dreams, speech events, and short narratives. In contrast, long narratives require external organization. In the course of history, the invention of textual mapping (i.e., writing) allowed for larger linguistic constructions, which in turn influenced the way literate people thought. In short, as minds created texts, texts created minds. As literacy became more widespread, narratives became more elaborate.

Subsequently, this arrangement of fragmented thought into linear coherence likely contributes to the criticism of formulaic fiction writing books. Though popular, such books tend to treat language, expression, and writing as a problem of writing (literacy) only. Yet writing is not language, it is an expressive representation of language, which in turn is a manifestation of thought and emotion. Long narrative is the arrangement of this expressive representation (see [Sanford and Emmott, 2012](#), *Mind, Brain, and Narrative*). Specifically, fiction is one type of narrative construction, and the novel is a domain-specific written manifestation of fiction that entails its own affective and embodied characteristics (see [Fairchild, 2019](#), on the psycholinguistic distinctions between different types of writing).

Freedom to Read

The second historical condition for the emergence of the novel was (and remains) the freedom to engage written fiction. Though expressive freedom for thinkers, artists, and writers is necessary for creativity, equally important is an audience's political and economic autonomy. Historically, literacy throughout nearly every society first evolved through the aristocracy, who had the time and freedom to engage advanced language development such as poetry and prose. As civilizations became wealthier and more stable, literacy not only expanded to other tiers of society but became more specialized. Whether Greco-Roman, Persian, Indian, Chinese, Japanese, or Arabic, the heights of each civilization produced urban classes of craftspeople, merchants, traders, and educators, who collectively had enough political and economic freedom (i.e., time away from social obedience and laboring for sustenance) to produce, consume, and trade printed materials. These materials expanded into domain-specific verbal art forms such as published poetry and prose.

In the modern West, what recognizably became the modern novel occurred in step with the European Enlightenment and the Industrial Revolution. These events placed emphasis on intellectual and economic autonomy for the socio-economic commoner, an ideology routinely disseminated through print. As reading consumption increased dramatically during the period and publishing markets expanded, so did the desire for more product variety. In the zeitgeist of a free Western democratic individual, the novel played to the privacy of the reader's own mind and own pace. In short, the freedom to read (and write) a long piece of fiction exemplified the level of one's personal autonomy.

Reproduction

Contributing directly to widespread literacy and audience freedom, the third historical precursor for the emergence of the modern novel was the metal moveable-type printing press. Paper, woodblock printing, and eventually moveable type were all developed in China several centuries prior, which enhanced the production of art and literature across Asia. Due to international trade, both paper and moveable-type technology spread throughout the Arabic world sometime in the 13th century, eventually arriving in Europe soon thereafter.

Although the first book produced by metal moveable type occurred in Korea (c. 1377), it was Europe that saw Johannes Gutenberg's mechanical printing press (c. 1439). The invention not only revolutionized book production, it also fostered mass literacy and the freedom of the individual author and reader. Just as electronic publishing would one day change the way information and products were managed, the printing press bypassed scribes and institutional authorities to give writers more direct access to readers. By the year 1500, European presses had turned out over 20 million copies of print items. A century later, the number had expanded to somewhere between 150 and 200 million. The likes of Niccolò Machiavelli's political treatise *The Prince* (1513) and the entire catalog of William Shakespeare (c. 1589–1613) appeared during this time, as did Miguel de Cervantes's *Don Quixote* (1605), often considered the first modern novel of international recognition.

Modern Novel Writing

What do novels reveal about creative writing processes? The quest to pin down a definitive writing process has been the subject of prescriptive writing advice for decades. However, in a review of evidence on creative writing processes, [Lubart's \(2009\)](#) general conclusion was that creative writing is a kind of problem-solving process so idiosyncratic that likely no single process could exist.

The problem goes beyond that of merely defining the specifics of a particular domain. In the domain of novel writing, processes can vary author by author and often novel by novel, with an individual author sometimes producing one title alone at night in the dark and then producing the next title by day in a crowded coffee house.

Rather than trying to isolate a recipe that aspiring authors should or should not employ, the creativity concept of flow, or optimal experience (Csikszentmihalyi, 1996), presents a promising alternative for the understanding and development of fiction writing. In a review of qualitative research on flow and the art of fiction, Perry (2005) addressed the mental states, habits, and environmental conditions in which numerous successful authors find themselves. Exploiting these states and conditions liberates each individual author from prescription, which allows them to conduct writing in whatever personalized manner is effective.

The considerations around flow match the advice that Burroway (2019) presented in *Writing Fiction*, one of the most commonly used practical fiction guides of the past 30 years. In addition to outlining the major components (objects of craft) for aspiring and practicing novelists, Burroway asked writers to consider themselves as central to individualized writing processes (methods of craft). In terms of application, when trying to enter into something like a state of optimal writing, writers and writing processes should be treated as inseparable. Burroway organized her advice around nine topics:

1. The writing process: whatever works.
2. Seeing is believing: detail, imagery of emotion, voice, rhythm.
3. Direct characterization: dialogue, appearance, action, thought.
4. Indirect characterization: interpretation, credibility, purpose, complexity, change.
5. Setting: atmosphere, harmony and conflict, symbolism.
6. Plot and structure: conflict-crisis-resolution (the story arc).
7. Point of view: who speaks to whom, and in what form and at what distance?
8. Comparison: metaphor, simile, symbols, the object correlate of the conflict.
9. The rewriting process: what is working and what is not?

The Reality of Drafting

Fiction writing is a domain-specific enterprise, where writing reasonably well in one domain is no guarantee, nor indicator, of being able to draft a novel. Fig. 1 shows the pyramidal stages in the practical development of a novel today, which ties into the creativity literature (Csikszentmihalyi, 1996; Simonton, 1994) on eminence and the great investment of time needed to write successfully. Most aspiring novelists never get past the first stages, of having some initial ideas, completing a few pages, and maybe completing a draft. If a writer manages to arrive at a working manuscript, an industry consensus is that fewer than 1% of these manuscripts are ready for publication, leaving the writer with one of three choices: do more redrafting, start a new story, or quit writing. If a manuscript does manage to become a published novel, less than 10% of these will achieve critical or commercial success, and less than 1% of these successful titles will become bestsellers.

Emotional Crafting

In *The Emotional Craft of Fiction*, prominent literary agent Donald Maass (2016) stressed that a successful novel is, among many things, a successful emotional rendering, a point supported in various psychological, philosophical, and narrative investigations of fiction (e.g., Carr, 2014; Hogan, 2011). Sanford and Emmott (2012) reviewed research suggesting that fiction writing is also a textual representation of embodied experience, a conclusion supported by a quantitative study (Fairchild, 2019) indicating that prose fiction is perhaps the most embodied form of writing. Writers can deliberate over the proper ways of crafting a text and are even permitted a certain number of fiction writing blunders, as long as the story hits the reader in the emotional gut. Without this affective resonance, which is partly an embodied resonance, a novel loses a reader's interest.

As Carr (2014) discussed in a review of research on the aesthetics of literary fiction, readers—in their complex plurality—are an integral social and psychological component in determining the aesthetics (desirability and creativeness) of a published novel.



Figure 1 Stages of a novel.

Although evidence shows that fiction readers often learn something new about themselves and the world around them, they also seek (consume) stories to satisfy preexisting beliefs, feelings, and worldviews (Carr, 2014; Maass, 2016). The situation generates a precarious line that authors must walk, between telling challenging stories and placating the human desire for familiarity and comfort.

Fiction Narration

“The house of fiction has many windows but only two or three doors,” wrote literary critic and scholar James Wood (2008) on the opening page of *How Fiction Works*. The two doors refer specifically to third-person (he/she) and first-person (I) narration, and nearly every novel ever written is in one of these two voices. Third-person is typically written from the omniscient view, whereas first-person is sometimes referred to as the unreliable voice, because the narrators tend to know less about themselves than the readers eventually do. In practice, neither type of narrator is entirely reliable nor unreliable. Third-person can range from narratively neutral to narratively biased and sometimes heavy handed. Likewise, first-person narrators can be intimately reliable, such as Charlotte Brontë’s *Jane Eyre* (1847) (a work that helped revolutionize individual character consciousness in modern fiction). First-person can also be obsessively unreliable, such as the anonymous narrator of Dostoevsky’s *Notes from Underground* (1864) (a work that demonstrated the limits of character self-awareness for generations of future fiction writers).

Both Brontë and Dostoevsky revealed important aesthetic and psychological aspects of a narrative text, and what separates something like memoir, journal writing, or the personal essay from a novel. The primary distinction concerns the natures of nonfiction and fiction, of representing something that claims a basis in reality as opposed to using representational reality as a means to convey a theme, message, or emotion. Whereas the writer of a memoir, for instance, is typically expressing a personal perspective directly, the author of a novel will construct a narrator, and the narrator is the revealer of a story that automatically limits information about the writer. One purpose is to craft a kind of theatrical mask, or authorial character, to help take focus off the writer (i.e., biases off people, beliefs, etc.) and direct it toward the writing (i.e., focus on the messages and themes within the text).

The uses of masking and implication are as old as storytelling itself, and each is implicit in human behavior. In an in-depth introduction to narrative psychology, Laszló (2008) discussed how the implied voice occurs naturally, as a complex identity among the structures, psychologies, and historical truths of how people routinely and unconsciously construct their worlds and selves. Theatrical masking differs from ordinary masking in that someone like a fiction writer, both intentionally and unconsciously, will employ implied voicing to buttress the dramatic and thematic agendas. This engagement must not be confused with deception, which is an evasion of truthful understanding.

Although fiction authors can and often do borrow fragments of true life occurrences, they nonetheless invent characters and images throughout the rendering of the text. In the process, fiction authors make exponentially more conscious word and grammar choices, sometimes taking liberties with the accepted meanings and rules of linguistic engagement. Rather than trying to deceive the reader in this way, the author is typically intending to convey a more specific story or implicit emotional theme, one that is perhaps difficult to develop through conventional language alone. In *Deeper than Reason*, a treatise on emotion in art and literature, Rob-inson (2005) insisted that a novel should be understood in relation to its implied author, which serves as a buffer between writer, text, and reader. Formal devices, such as voicing, verb tense, and metaphor help build this buffered space, through which emotional, unsettling, and even disgusting subject matter can be engaged from a safe distance.

Domain Changes

What do novels reveal about a core creativity topic like domains and the conventions within each domain? Major bestsellers throughout history have ranged anywhere from 650,000-word epics like Victor Hugo’s *Les Misérables* (1862) to numerous 100-page novellas that include Charles Dickens’s *A Christmas Carol* (1843) and George Orwell’s *Animal Farm* (1945). The novella in particular, a literary form that began during the Italian Renaissance, enjoyed a dominant run in English-language markets in the latter half of the 19th century and early part of the 20th. The compact length (approximately 17,500 to 40,000 words) appealed to an emerging mass audience and an industry needing to sell books in quantity. In the United States, the novella was the premise for the market paperback, a cost-effective commercial product that could generate substantial sales from titles like Edgar Rice Burroughs’s *Tarzan of the Apes* (1912). For full novels (over 40,000 words) and works of literary fiction during this same era, word counts tended to be relatively low but there was considerable variation overall.

In the contemporary marketplace, most English-language novels fall within a range of 75,000 to 100,000 words, or roughly 300 to 400 manuscript pages. For unknown or first-time authors, the page-count heuristic is closer to 250 to 400 pages (62.5k to 100k words), as market research indicates that typically anything shorter and usually anything longer ends in lower sales (readers want something for their money yet tend to avoid lengthy novels by unknown writers). Accordingly, agents and editors generally reject new authors whose manuscripts fall outside this window. In comparison, established authors, for better or worse, often get away with a pattern of inflation, in which manuscript lengths increase as an author becomes more popular. Two authors known for inflated word counts are Stephen King and J. K. Rowling, but only after each broke into the fiction market with first titles that were the shortest of their respective careers:

- Stephen King,

first four novels and apx. word counts (in thousands):

<i>Carrie</i> (1974)	61k
<i>Salem's Lot</i> (1975)	152k
<i>The Shining</i> (1977)	166k
<i>The Stand</i> (1978)	471k

- Stephen King (writing as Richard Bachman),

first three novels:

<i>Rage</i> (1977)	54k
<i>The Long Walk</i> (1979)	85k
<i>Roadwork</i> (1981)	90k

- J. K. Rowling,

the seven Harry Potter novels:

<i>The Philosopher's Stone</i> (1997)	77k
<i>The Chamber of Secrets</i> (1998)	85k
<i>The Prisoner of Azkaban</i> (1999)	107k
<i>The Goblet of Fire</i> (2000)	191k
<i>The Order of the Phoenix</i> (2003)	257k
<i>The Half-Blood Prince</i> (2005)	169k
<i>The Deathly Hallows</i> (2007)	198k

Authors of Novels

What do novels reveal about creativity and authors? If for no other reason, a historical understanding of a novel (or any creative product) is important because time is important to creative judgment: the time of the novel's publication, the reputation of the novelist at different times in history, and the changing sentiment over time in the domain's field (gatekeepers, culture, marketplace). One example of this systemic confluence of domain, author, and field concerns the novelist and poet Mary Shelley (1797–1851). Only 18 years old when she completed her first draft of *Frankenstein* (1818), Shelley initially published the novel anonymously to deal with the age and gender biases of her day. A review from the prestigious *Quarterly Review* also captured the critical rejection typical for the novel at the time of its release:

Our taste and our judgment alike revolt at this kind of writing, and the greater the ability with which it may be executed the worse it is—it inculcates no lesson of conduct, manners, or morality; it cannot mend, and will not even amuse its readers, unless their tastes have been deplorably vitiated ([Croker, 1818](#), p. 385).

Although unfavorable among many critics, *Frankenstein* struck a chord with audiences and would eventually become the most important foundational piece of both modern horror and science fiction. Shelley today is considered one of the most influential female authors of the 19th century, yet this is a relatively recent phenomenon. As late as the 1980s, Mary was largely remembered for being the wife of Percy Shelley, whose poetry and reputation she helped elevate to eminent status after his premature death. Not until more female scholars appeared in academia did new collections of Mary's work emerge, along with the first full-length scholarly biography, which resurrected her writings and helped build her contemporary reputation.

Female Authors

Shelley's story, of creative talent, critical dismissal, and constant financial struggle during her lifetime, is not unusual for creative writers in general. For a widow like Shelley, the additional challenge was raising her only surviving child—a son who fortunately ensured that his mother did not die destitute as many writers had. While history contains similar stories of women in a struggle to catch up to male counterparts on most fronts of creativity, the presence of female fiction authors was so apparent by the middle of

the 19th century that British writer and critic Margaret Oliphant at the time declared an “age of women novelists” (cited in Connor, 2018, p. 139). Still today, in the history of English-language authors, the most enduring female names are from the 19th century (e.g., Jane Austen, Kate Chopin, the Brontë sisters) or from the first decades of the 20th (e.g., Willa Cather, Edith Wharton, Virginia Woolf).

In brief, women have been a major force in the development of the novel, and not just in the West. In Japan, for instance, Murasaki Shikibu drafted her 1,100 installment pages that became *The Tale of Genji* (c. 1002–1008), sometimes considered the first real novel in world history written in vernacular prose. Beyond Murasaki, however, female names remain largely absent from the canon of Japanese literature, which studies in Japan and the West (e.g., Simonton, 1992) attributed to the patriarchal reinforcement of Japanese civilization and not to the lack of creative women. Written Japanese itself is conducted by using three scripts: a formal Chinese pictography (*kanji*) and two phonetic scripts. Women, who were excluded from formal language learning (*kanji*), first mastered the more vernacular and colloquial forms of phonetic writing, as Murasaki did. One result was a prose form that laid the foundations for centuries of Japanese fiction by both female and male authors.

In Western societies, the increase in the number of female authors occurred in step with the rise of female literacy. Literacy was deemed useful for increasing a young lady’s prospects for marriage. However, the more that young women read, the larger appetite they developed for fiction, for wanting a single life, and for pursuing writing careers themselves. This desire for independence fueled a recurring backlash toward women authors, their publications, and their readers, all deemed romantic, emotional, and misguided by fancy and fantasy. *Don Quixote* itself was Cervantes’s rebuttal to chivalry, enchantment, and romance, a rebuttal that critics later transformed into the realist-idealist sensibility that became the platform for modern fiction.

The dominance of male literary influence, as seen throughout most of the 20th century, was partly a phenomenon of Western modernism itself. The birth of modernism came at the expense of romanticism, when subjective language was replaced by a pointed psychology (i.e., a mislabeled feminine emotionality replaced by a masculine seriousness). The timing occurred with the emergence of mass education and literacy, commercial mass market publishing, official literary prizes, and academic literary entrenchment. The full arrival of the American novelist occurred during this time, led by such names as William Faulkner, F. Scott Fitzgerald, Ernest Hemingway, and John Steinbeck. The environment helped ensure that the modern masculine voice would be the voice of the 20th century novel. From its inception in 1901 through the year 1990, the Nobel Prize in literature was awarded 85 times, yet only six times to women (in 1909, 1926, 1928, 1938, 1945, and 1966). Women fared better with the Pulitzer Prize for fiction, receiving 26 of the 89 awards (29%) as of 1990. Not until the end of the 20th century would Western female authors reestablish their strong creative influence over fiction writing and the market.

The Field of Novels

What do novels reveal about creative conventions, about the function and practices of the novel’s field including the publishing industry?

Genre

In the verbal arts, the three genres from Ancient Greece are poetry, drama, and prose. In the business of novel writing today, the two most fundamental types are literary fiction and commercial (genre) fiction. Commercial fiction is what the descriptor implies: novels that generate profit for publishers, as fiction consumers tend to select titles based on (i) loyalty to a particular author and (ii) interest in a particular genre. In literary fiction, the product is the prose itself, often focusing on the inner lives of the characters attempting to navigate traditionally, commonly, or universally held themes such as love and death. Such novels take most of the prestigious literary awards, and many can become bestsellers, though the majority tend to lose money and are thus typically handled by publishers dedicated to this type of fiction. In practice, with the recent industry emphasis on distribution and marketing, nearly every novel is now categorized by one or more genres. In query letters to most potential agents or editors, unknown authors (literary and commercial) must provide genre identification for their pitched manuscripts if they hope to be considered at all.

Given the emphasis on genre, the number of fiction genres has expanded over time along with the variety of subgenres. An example is science fiction (SF), which developed subgenres that include hard SF (technologically driven), soft SF (character driven), and space opera (galactic warfare and melodrama). Genres also overlap with one another. For instance, fantasy is a genre on its own, but fantasy also exists as a subgenre within nearly every major genre (e.g., fantasy western). Seven of the major genres and their common subgenres include:

- Fantasy: fairytale, magic realism, sword & sorcery, urban;
- Horror: aliens, hauntings, mind control, supernatural;
- Mystery/Crime: cozy, detective, hardboiled, police procedural;
- Romance: contemporary, gothic, historical, paranormal;
- Science Fiction: alternate history, feminist, cyberpunk, steampunk;
- Thriller: espionage, legal, medical, military, political, techno; and
- Western: cattle drives, lawmen, lost mines, railroads.

The genre market extends across cultures as well, including the best-selling genre of all time: romance. For the year 2008, *The Wall Street Journal* reported that nearly 75 million people globally read English-language romance novels, and the leading American romance publisher, Harlequin, sold half of its product internationally. The number of romance subgenres is currently in the dozens, with contemporary romance generating half of the entire genre's sales. There is even a lucrative graphic novel subgenre in Japan known as boy's love (male homosexual romance), which is created and read almost exclusively by women.

Agent Perspective

Historically, the middleperson who helped transition a fiction author's manuscript into a published novel was the editor. Though the position of editor is still paramount in the publishing industry, many fiction editors do little editing and have become acquisition agents for publishers: private, profit-driven businesses that invest little interest in fiction authors who lack commercial track records. The result has led to a growth in the number of literary agents. Although many experienced novelists have learned to deal with publishers directly, agents have become a common bridge between art and commerce, an area in which most writers are the least experienced and the least comfortable.

Unlike a writing teacher or a fellow writer, who might devote considerable time and sensitivity to an aspiring writer's work (or unlike an academic who spends considerable effort on abstracting information on creative writing), literary agents operate in much simpler terms. Is a manuscript any good (i.e., is it publishable)? Will anyone buy it? More than 99% of the time the answer to both questions is no, and most queries submitted to agents are rejected outright. To the inexperienced author, this can seem like a hasty judgment of one's hard labor (contributing to the growth of self-publishing despite its poor showing for writers). In practice, the agent is often the best and sometimes only ally that a novelist will have. Reputable agents are successful only if their clients are successful, securing publishing deals in an industry saturated with product. Unlike nonfiction publishing, where a book proposal leads to a commissioned deal, a novel must first be completed and dealt to a publisher much like a finished painting is brokered to an art dealer. The result is an established industry that favors the commodity of known authors. For a new author, the best option is often a less-established agent, one willing to take risks on an unknown.

The Continuing Evolution

This entry attempted to address novels and creativity in relation to the aspects of domain, individual creator, and field. Historical and contemporary developments inform the understanding of creative products like a novel (and a creative person like a novelist) as emerging from a synergy of many forces rather than isolated occurrences.

One conclusion is that novels, novelists, and their writing processes manifest in the plural. In year 1953, James Baldwin published his semi-autobiographical first novel, *Go Tell It on the Mountain*, a breakout title for African-American writers and still listed on most top-100 lists for best English-language novels. In 1958, Nigerian author Chinua Achebe published *Things Fall Apart*, a breakout title for African writers and still the most widely read African novel globally. In 1968, the Nobel Prize for literature was awarded to Japanese novelist Yasunari Kawabata, the first non-Caucasian in the Prize's history, for a body of work that explored the boundaries between human beauty and frailty, between deep introspection and illicit behavior. In 1989, Laura Esquivel published *Like Water for Chocolate*, a number one bestseller in both her native Mexico and in the United States. What each of these novels had in common were their differences: different writing processes by each author, different uses of voicing and character perspective within the texts, and different publishing avenues toward different readers.

Baldwin, Achebe, Kawabata, and Esquivel are but four names that represent the diversity and international range of the novel today. Authors from different cultures, in different languages, have crossed old thresholds to take the novel in new directions while following domain conventions such as narrative, theme, plot, story, character, and human emotion, and field conventions such as genre, publishing trends, and the plurality of reader audiences. In conclusion, the novel is an established, creative form, but novels and novelists are not static and continue to evolve.

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Novelty[☆]

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Glossary

Domain An area of knowledge or expertise.

Novelty A kind of variability involving responses that are new and (1) appropriate/useful, (2) generative, or (3) influential.

Paired Constraints Tools for increasing novelty. Constraints come in pairs. One of each pair precludes a reliable, predictable response while the other promotes an atypical, unexpected one.

Problem Space How a problem is represented by a solver. The space has three parts: an initial state, a goal state, and a search space in which a solution path is constructed.

Solution-by-Substitution Step by step construction of the solution path.

Variability A measure of how differently something is done. Moderately high variability is associated with usefulness; higher variability, with influence.

NOVELTY is necessary but not sufficient for a response to be considered creative. Nonetheless, given that the criteria for sufficiency (usefulness, influence, etc.) are many and shifting, novelty may be the optimal object for manipulation and measurement. This entry considers how paired constraints preclude low variability, high probability responses and promote novel ones.

Novelty, Variability Levels, and Learning

Variability can be conceived as a continuum with minimal and maximal degrees of difference in how something is done. Fig. 1 presents one version of such a scale. Responses closer to the minimal end of the continuum are predictable because they tend to be performed in remarkably similar ways. They increase variability from stereotyped (invariant) to reliable (habitual) to expert (variation between “successful” solutions).

Responses closer to the maximal end are less predictable because they are, by definition, quite different. Novelty is in this range because new responses appear after more likely ones have been exhausted. The kinds of novelty include responding that is new and appropriate or innovative or influential.

Appropriate/useful is the most common kind of novelty: it simply solves the problem at hand. In generative novelty, the solution propels its own development. Influential novelty expands domains. Here, at the highest level, the novelty changes the way others look at, think about, and, importantly, solve problems in a particular domain.

[☆] *Change History:* August 2019. Patricia Stokes updated the text throughout the article.

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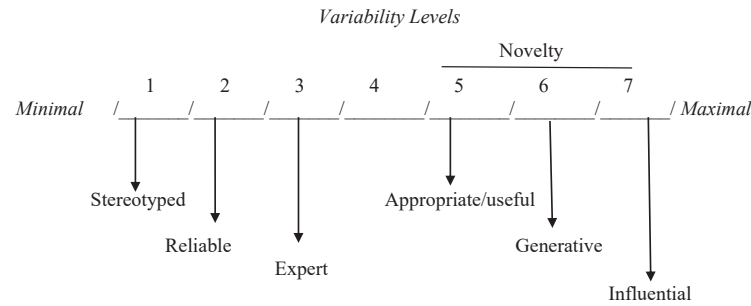


Figure 1 Variability continuum.

Learned Variability Levels

Learned or habitual variability levels (how differently one usually performs or applies a skill) are domain-specific and learned/acquired early in skill acquisition. High levels ensue when training requires and rewards doing something in multiple ways. This kind of regime can be thought of as difficult-but-doable; accelerated training is another, in which rapid acquisition of different skill components precludes repetition and promotes variation.

Novelty, Problem-Solving, and Constraints

A counter-intuitive (i.e., counter to common usage) strategy for increasing novelty involves imposing constraints, plural and paired. Since the pairing is a convention from problem-solving, our discussion starts with problem spaces.

Problem Spaces

A problem space is how an objective problem is represented (subjectively) by a potential solver. Experts and novices differ considerably in this: the expert's representation is both more elaborate and more efficient. In both cases, however, the parts of the space are the same. There are three:

- The initial state, which represents the current situations.
- The goal state, which represents the desired, changed situation.
- The search space, in which a solution path is constructed to transform the initial into the goal state.

Paired Constraints

In problem solving, constraints come in pairs that guide the construction of the solution path by precluding elements of the initial state and promoting substitutes. The path is the series of substitutions that produce the promote column. As shown in [Table 1](#), there are four constraint categories.

Goal constraints preclude an existing solution (the initial state) and promote a novel one (the goal state). Source constraints are elements that you work against (preclude) or with (promote). Subject constraints involve content or motif; task constraints, materials and how they are used. Constraints cascade when one pairing suggests or requires another. The greater the cascade, the greater the novelty.

Table 1 Constraint categories

Category	Pairings
Goal	Preclude an existing style/solution → Promote a novel style/solution
Source	Preclude (work against) specific elements → Promote (work with) others
Subject	Preclude particular themes/motifs → Promote others (often opposites)
Task	Preclude traditional materials and Manipulations → Promote alternative materials and Applications

Table 2 Constraints for original tile designs

Category	Pairings
Goal	Preclude “intruder’s” designs → Promote substitutes
Task	Preclude symmetry → Promote asymmetry
	Preclude multiple colors → Promote limited colors (red/black)
	Preclude staying inside grid → Promote extensions outside the grid

Novelty Problems

There are two kinds of novelty problems. One, the Basic Novelty Problem is initiated by an outsider (typically a researcher studying conditions that facilitate novelty or variability) who presents the problem to someone else (usually a novice) for solution. Their solutions belong in the novel/appropriate and category. The other, the Advanced Novelty Problem is initiated by an expert solver. Solutions here may become generative or influential.

Basic Novelty Problems

Increasing novelty. In these problems, those reliable, habitual responses found at the low end of the variability continuum are *precluded*. In their places, newly appropriate or useful responses are *promoted*. Examples are sorted by kind of task.

Drawing. The first two studies in this section involved children. In the first, a promised reward for completing a drawing task only increased originality when children were given *explicit* instructions that the drawing be unusual, or when they had just been rewarded in the same classroom for coming up with unusual rather than ordinary uses for objects. In the latter case, the *context* seems to have cued *transfer*. This is basic operant conditioning: in this context → this response leads to → this consequence: Here, in this classroom → *precluding* usual and *promoting* unusual responses leads to → reward.

In the second, where the task was making drawings that incorporated pre-printed circles (16 on a single sheet of paper), originality (operationalized as complexity) depended on the drawing examples presented. One group of children were shown a single smiley face; the other saw both a goldfish bowl (with parts protruding from the top and bottom of the bowl) and a bicycle (using two adjacent circles). Unsurprisingly, originality was higher in the dual example group. In this case, the examples served as an *implicit* constraints: either *preclude* simple, stay inside the circle → *promote* complicated, draw outside the circle, combine circles, or vice versa.

The next two studies were done with college students. The very early one *explicitly* instructed students to make abstract designs with a black pen: first, three designs different from each other, then different from the first three, then different from designs made by an “intruder” (the intruder was the experimenter), finally, just 3 designs. The very interesting result was that the most original designs appeared in the final set, when the designs were noticeably different from the “intruder’s” drawings. This result was recently replicated (but not yet reported) using with students using magic markers to draw tile designs on 4 by 4 grids. Again, the most original designs appeared in response to the “intruder’s” designs. It seems that *precluding* elements of your own style is not as simple, or perhaps as obvious, as *precluding* elements of someone else’s.¹

Table 2 represents a possible problem space for the final set of tile designs. The preclude column lists elements of the “intruder’s” designs; the promote column, the student’s substitutions.

Inventions. In one set of studies, researchers manipulated choice of inventive categories (subject constraints) and parts (task constraints). The *explicit* goal was to produce novel, useful objects, by combining the parts. The researchers reasoned that greater choice would promote conventional thinking; thus, they predicted that limiting choice would *preclude* habitual/conventional responses and *promote* novel ones. Their prediction was correct. Compared to conditions where students chose either category (e.g., furniture or toys) or parts for combination (e.g. wheels, handles), the highest originality ratings were given when both category and parts were randomly specified rather than selected. In another, related study the *explicit* goal was designing a toy for a child (age 5–11). Again, novelty ratings were higher when parts were restricted.

Movement. In a famous early study, porpoises were rewarded for swimming and leaping in ways that were outside the species’ normal repertoire. Novelty was defined *across* sessions: to earn a fish, a response had to differ from all responses in all sessions. So, *preclude* all previous topographies, *promote* novel ones. Did the porpoises notice out what the fish were for? Yes. As training proceeded, new topographies appeared closer to, and even, at the start of a session.

More recent work in sports psychology manipulates practice task constraints to increase “functional novelty,” i.e., new, efficient movements based on discovery/exploratory practice. What gets explored are “affordances,” properties of objects that suggest ways to use the objects. For example, a pen “affords” writing. It could also “afford” stabbing or scratching. manipulations shown to increase exploration (and facilitate discovery of novel efficient movements) are changing task constraints and suppressing habitual responses. In both cases, current conditions and responses are *precluded* in order to *promote* exploration and, as a result, functional novelty.

¹This (precluding elements of another’s style) is how shifts in art paradigms occur. Pop Art, for example, precluded specific elements of Abstract Expressionism and promoted direct opposites.

Increasing Variability. In these problems, the goal is *precluding* lower and *promoting* higher variability per se. Most familiar to creativity researchers are Divergent Thinking problems, solutions to which are measured as number of different responses (fluency), number of different response categories (flexibility), and number of unusual responses (originality). Less familiar are procedures that specify lags or manipulate task difficulty.

Lags. A lag is the number of prior responses from which a current response must differ. For example, a lag of three means that reward only follows a response (or series of responses) that differs from three prior ones. Imagine three-response sequences made on right or left pointing arrow keys: the sequence RRR would be rewarded if it occurred after the sequences RRL, LLL, and LRL, but not if any triad was repeated (e.g., RRL, RRL, LRL). Lags clearly preclude repetition and promote variation. They have been shown to increase response variability in pigeons, grade school and college students. Pigeons have met lags up to 50; college students to 25; fifth graders to 10.

Another procedure is known as frequency dependent selection. Here, less probable or less frequent responses are momentarily selected for reward. For example, with the same left-right key press pair, as R increases in frequency, reward decreases for R and increases for L. Depending on the relative probabilities specified by the reinforcement schedule, some stable (and more or less variable) alternation pattern will earn maximal reward.

Task Difficulty. Implicit variability criteria are embedded in all tasks; they differ depending on whether the task is easy or difficult, simple or complicated. An easy or simple task requires little variability: few things need be tried to master it, few to maintain it. Difficult or complicated tasks require higher variability: many things are necessary for mastery and maintenance. Importantly, whether high or low variability levels are temporary or habitual depends on when a particular type problem is introduced. As mentioned earlier, habitual variability levels – preferred performance ranges – are acquired early in skill acquisition. If easy/simple tasks are encountered then, the levels will be lower than if training involves difficult/complicated tasks.

Computer maze games have been used to *preclude* or *promote* high or low variability levels. For example, two groups of college students played different versions of a game with easier/simpler or more difficult/complicated set of constraints. The easy set required exiting the maze at specific locations; the difficult one, exiting at the same locations by paths that differed from some number of prior paths (in other words, lags). For example, exit from locations C or D by a path different from 2 immediately prior paths. As the number of locations decreased (from 3 to 1), the lags increased (from 0 to 5). The more difficult training task (combined locations and lags) generated higher variability both when the training conditions were in effect, sustained it after they were relaxed (i.e., when all paths to all locations earned points), and facilitated *transfer* to a novel task (alternating exits on the maze). The transfer effect, suggest multiple researchers, is due to high variability requirements sensitizing the learner to changes in condition.

Domain Specific Novelty Problems

In Domain-Specific Novelty Problems, the initial state is usually an existing, accepted style or solution type. The initial and goal states together are the preclude-promote pairs of the goal constraint. This section summarizes constraints in two domains – architecture and theatre – that attained the highest level of variability criteria, influence.

Architecture

Here we focus on one type of architecture (domestic) and one architect (Frank Lloyd Wright). The open, interconnected spaces of Wright's Prairie (palatial) and Usonian (practical) houses were highly *influential*, prototypes for single-level ranch house, satellite spaces, and great rooms. As indicated in Table 3, his goal precluded the straight-sided box with its small, separate rooms (initial state), and promoted in its place, a radically new architectural style that he labeled "organic" (goal state). For Wright, "organic" was synonymous with "continuity." Continuity involved three relationships: between interior and exterior spaces; between interior spaces; between surface and decoration. To accomplish this, he sourced horizontal elements (overhanging roofs, transoms, open spaces separated by sliding screens) from the traditional Japanese dwelling; balconies and verandas from the South; hearths and porches from the Midwest; simplified, stylized, and importantly – unbroken – surface decoration from his mentor, Louis Sullivan.

The site was critical in that the house conformed to, was an extension of, its topography. Most Wright sites were flat, which accounts for the horizontality of the Prairie and Usonian houses. The most famous exception is Falling Water, with cantilevers that overhang and mimic its waterfall. Critical to realizing a continuous, open plan was the modern of materials at the time: reinforced concrete solved the problem of support. Multiple interior walls (which necessitated small, box-like rooms) were supplanted

Table 3 Constraints for Frank Lloyd Wright

Category Pairings		
Goal	Preclude the "box"	→ Promote the "organic" (continuity)
Task	Preclude interior-exterior separation	→ Promote site-specific elements (cantilevers, strip windows, overhanging roofs, terraces)
	Preclude interior separation	→ Promote open, interconnected plans (piers, columns, screen walls)
	Preclude surface-structure separation	→ Promote structure-specific elements (decoration follows form)

Table 4 Problem space for Commedia

Category	Pairings
Goal	Preclude Elizabethan theatre → Promote formal exaggeration of reality
Subject	Preclude changing subject → Promote single subject (survival)
Task	Preclude changing characters → Promote prepared parts
	Preclude realistic → Promote caricatured (types, masks, etc.)
	Preclude written, memorized → Promote improvised
	Preclude acts → Promote scenario

by fewer, lighter supports (piers, columns) beyond which Wright's organic, continuous plans could expand. Bridging the final separation (between surface and structure), decoration was derived from form: linear, geometric elements and patterns iterated the shapes of their supports. The house, in Wright's plans, was no longer divided.

Theatre

The epitome of influence in comedy is *Commedia Dell'Arte*. What did Commedia work against? Basically Shakespeare, the most famous of Elizabethan dramatists. The *preclude* column in [Table 4](#) lists elements found in Shakespeare's comedies and tragedies. The *promote* column presents the substitutions, the solution path that realized *Commedia's* sub-goal, the formal exaggeration of reality.

Commedia's modular structure (prepared parts/scenario) is formal, the exaggeration in the caricatured types with their associated masks, *maschera* and *lazzi*,² and the reality in the singular subject (survival, endlessly threatened by the problem that propels the play). The problem places the types in a scenario to which each reacts spontaneously because she/he is always prepared ("in character" and often, in a troupe, in the same character). The problem proliferates, the scenario shifts, "solutions" produce new problems, until (at last) order is restored, and survival (temporarily) assured.

Influence? The earliest company appeared in Padua in 1545. There are current companies and multiple offspring, including sitcom, soap opera, stand up, and of course, improv. What keeps *Commedia* and its progeny popular? Something similar to sports. "The game is always the same, rules, players, props, and playing field are givens. This makes exceptional play not only possible but noticeable. Appreciation is maximal because the structure is known; anticipation is maximal because the outcome isn't" (Stokes, 2016).

What are *Lucy*, *Jerry* (Seinfeld), and (Unbreakable) *Kimmy Schmidt* if not children of *commedia*?

Concluding Questions and One Suggestion

The Questions

There are multiple questions about novelty.

- One involves criteria: is something not-so-new, sort-of-new, truly new?
- Two relates to the truly new: how easily, how soon, will it be accepted, adopted, adapted?
- Three is the most basic and the most difficult: How do you do something new? The answer, developed in this chapter, is you use constraints to *preclude* a current style/solution and *promote* a substitute.
- Four follows from three: where do the substitutions come from? The answer is something new (to this chapter): the *tool box* inside your head, the one you can't think outside of.

And one question about the tool box: what's inside it?

Two things: Basics and borrowings.

Basics are your expertise – things you know and things you can do. This is where training for novelty comes in. Acquisition of basics should begin early and be accelerated so that students not only acquire repertoires replete with elements for recombination and restructuring, but also the high habitual variability levels necessary to do so.

Borrowings are things that make your tool box bigger. They come from other domains. (Paired constraints are a strategy you can borrow from problem-solving). They are things noticed when needed. (Think of Pasteur and chance). Borrowings make your tool box bigger.

The Suggestion

The suggestion should be obvious. *Make your tool box bigger*. Absorb, acquire, copy, collaborate, investigate, and do take chances. Since you can't think outside the tool box, the novelty of your solutions depends entirely on its contents.

²The mask is a half-mask, leaving the lower lip and chin uncovered. This precludes using facial expressions to convey emotions, and promotes the *maschera* (gestures, postures, gaits, and attitudes) associated with each mask. The *lazzi* are prepared comedic bits linked to specific masks.

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O

Opera

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Introduction

Opera is the pinnacle of the performing arts, incorporating singing, acting, orchestral music, and sometimes dance. For good reason, composer Richard Wagner called opera *Gesamtkunstwerk*, or “the complete work of art.” An art form more than 400 years old, opera is a profusion of laments, patriotic choruses, intricate quartets, triumphal marches, flirtations, jealousy, and love. In the words of opera and film director Franco Zeffirelli, “Opera is a planet where the muses work together, join hands and celebrate all the arts.”

Creativity exists among the eminent composers and singers, and also among less visible participants. Dozens of talented artisans contribute to every production: set designers, costumers, and lighting designers, exhibiting what has been called “everyday creativity.” Administrators strive to make appealing repertoire choices and effective marketing campaigns to retain established audiences and entice new ones.

After a brief history, the following sections describe the creative contributions of composers, librettists, conductors, stage directors, and others, asking, “*In what way* is each opera participant creative?”

History

Opera as we know it dates from 1597, as an elite musical form for royalty and other privileged classes, setting to music the ancient tales of gods, goddesses, and kings. Musical styles evolved, from baroque to bel canto, romantic, verismo, modern, and post-modern. The focus on gods and royalty faded, comedies about clever barbers, country romances, and sleepwalkers won admirers, and by 1853 Verdi’s *La Traviata* sympathetically portrayed a high-class courtesan’s sad ending. The even bigger departure in Bizet’s 1875 *Carmen* and other verismo operas at the end of the century depicted life and death among peasants, dock workers, soldiers, and rebellious independent women.

Accordingly, the level of cultural knowledge required of a patron changed over time. When operas were about the doings of gods and kings, one had to be familiar with the classics to gain the most from an opera. *Verismo* operas of the late 19th century brought stand-alone stories and dialogue with minimal reference to the common cultural heritage. Knowing the language in which the opera was set once made a greater difference than it does now, when glossy programs offer plot synopses and supertitles translate the dialog in real time.

Etiquette and decorum for audiences also changed. Dressing up for the occasion may once have been common, but today expectations have loosened so that attire varies from formal to blue jeans – though those wearing the latter are sometimes the most knowledgeable patrons in the house. Rituals such as shouting “bravi” correctly in Italian and waiting by the stage door to greet favorite performers persist. Throwing bouquets during curtain calls has dwindled, perhaps from distaste for the spectacle of singers awkwardly dodging flowery missiles.

In the 20th century, a movement variously called atonal, twelve-tone, and Serialism rejected traditional music theory and harmonies, favoring dissonance, irregular rhythms, and jarring sounds. It became fashionable among certain people, including critics who (perhaps dreading to resemble unlucky earlier critics who panned *Rigoletto*, *La Bohème*, and other masterpieces), praised them (see [Reviewers](#)).

With few exceptions, these operas were not liked by American audiences. Finally, general directors realized that most twentieth-century operas were repelling their patrons and began to practice risk aversion by not scheduling them. Matthew Shilvock, General Director of San Francisco Opera, observed a regional difference between opera cultures, noting that “There’s still a very active and respected tradition of more atonal work, and more contemporary, non-lyrical works can sell out theaters in Europe” (personal communication, March 6, 2019). However, David Gockley, one of America’s great impresarios, concluded: “After three centuries of tonal consonance in music, the atonal revolution of the early 20th Century, brought on by Schoenberg and his Second Viennese School, blew the musical world apart Finally, in the 1970s Philip Glass brought his signature minimalism to the Opera ... It has helped to remove the stranglehold that Serialism had exerted on the art form” (personal communication, January 6, 2019). Newer operas are more likely to be approachable, even lyrical.

Composers

When one thinks of opera and creativity, one may naturally think first of composers – those who seem to summon music from their souls, who create something in ways that most people can’t imagine.

As in many art forms, most composers first master the styles of their times, and those with talent or genius then develop their own distinctive, recognizable styles. Early Wagner sounded like Carl Maria von Weber; early Verdi sounded like late Donizetti. Creativity and the individual voice are not necessarily harmed by thorough instruction in one’s tradition! Having developed their own styles, composers then varied in their approaches. Beethoven carried notebooks with him everywhere, so he could jot down musical themes that spontaneously occurred to him. Mozart had entire works completed in his mind before writing them down. Young Alma Deutscher says that music constantly runs through her head; for this reason she is often called “the second Mozart.” Like Chopin, both could improvise, which suggests that at least for some composers some of the time, the music arrives unbidden and unanalyzed. Some composers, such as Rossini and Donizetti, composed so rapidly that they could launch several new operas a year.

Yet even the most facile inventor faces the task of converting inspiration to completed written work. Beethoven’s labor was notoriously effortful after initial inspiration. Furthermore, opera composers must work in collaboration with librettists, impresarios, and (in past centuries) censors, complicating the process. A composer may also borrow material or styles. Some opera composers (Tchaikovsky, Bartok, Vaughan Williams, Floyd) included quotations of folk songs, or wrote original music intended to resemble folk songs.

Another question pertains to the way the composer works, its creative process – is it emotion or intellect? [Konecni \(2012\)](#) strongly asserted that composing is primarily an enterprise of “contemplation, analytical and technical skills, problem-solving, and planning – in short, reason.” This may have been true of the classical era and of the 20th century, whose 12-tone/serialism products often resemble intellectual exercises. (Perhaps he is one of those musicologists who, like Kozbelt and Simonton, make quantitative analyses of career trajectories, comparative eras of productivity, etc.). But some composers, such as Berlioz, Liszt, and Schubert, stated explicitly that indeed, their music was an expression of their own emotions. Perhaps it is a mistake to attempt to declare music solely one or the other. Tchaikovsky wrote to his patron, “What has been written with passion must now be looked upon critically, corrected, extended, and most important of all, condensed to fit the required needs of the form. One must sometimes go against the grain in this, be merciless, and destroy things that were written with love and inspiration.”

Of the hundreds of composers who have attempted the opera form, a handful rule the tops of the charts (Verdi, Mozart, Puccini, Rossini, Wagner, Richard Strauss, and Bizet). Others, famous in their own days, faded from the repertoire. [Simonton \(1998\)](#) found that an opera’s initial reception (enthusiastic or tepid) was a good (but not perfect) predictor of its success in the long term. After examining the careers of 59 classical composers ([2000a](#)), Simonton concluded that, although the acquisition of expertise over time plays a large role in the development of mastery, a composer’s career success cannot be entirely predicted by such measurable factors. It may be some comfort to creative people to realize, “The life of any creator is almost invariably an unpredictable succession of successes and failures, of hits and misses. A work that brings its creator unprecedented acclaim may be followed by an embarrassing fiasco” (p. 312).

Along with their artistic success, the social roles of composers changed over time, from being considered “the help” to their more recent status as honored celebrities. Still, all composers, no matter how creative and celebrated, have to please someone: noble patron, censor, general director, major donor, reviewers, and ultimately audiences.

Librettists

Very few composers create their own libretti – Wagner and Leoncavallo were among the exceptions. Generally, composers hire (or are assigned) a playwright or poet, who will take an existing work and revise it, deleting and adding until the text fits into a few hours on the stage. Singing takes longer than speaking, and costumes, scenery, and lighting replace description, so that much of the source material can be omitted. Subplots and minor characters may be added or deleted. Thus the librettist's creativity often involves *re-imagining*.

This sometimes requires a major leap. For instance, composer Jake Heggie was offered a commission for a new work, and contacted Terrence McNally, his collaborator on *Dead Man Walking*, for a story idea. He was daunted to hear McNally suggest Melville's sea-going novel *Moby-Dick*. A giant novel boiled down to 3 h? Luckily, Heggie kept listening. McNally suggested that the land-based scenes be eliminated and the opera take place entirely at sea. Heggie says, "I saw the twinkle in Terrence's eye and knew he had thought of a way the story could work – hugely challenging, but possible. I also knew that there was music inherently in the book and story – so if the libretto worked, the score would work" (personal communication, February 20, 2019). Heggie decided to end the opera with the novel's opening line, "Call me Ishmael" – a magnificent culminating *coup de théâtre*. Due to McNally's subsequent illness, Gene Scheer was brought on board as librettist (not the first time that a composer had more than one partner on a work), and their powerfully affecting opera, which premiered in 2010, has now been produced in twelve cities around the world, plus a DVD and a nationwide telecast.

Source Material

There are few totally new stories. In its early history, operas were typically based on stories of the gods, kings, and myths of Western civilization, though as late as the 1870s Wagner drew on Norse mythology. Traditional fairy tales stimulated others: Hansel and Gretel inspired Humperdinck's one masterpiece and Cinderella has inspired numerous composers, most recently the young prodigy Alma Deutscher in 2017.

The Bible is a storehouse for composers, as it has been for painters and poets. From the Old Testament we got, among others, Verdi's *Nabucco*, Saint-Saëns's *Samson and Dalila*, and from the Apocrypha, Floyd's *Susannah*. The New Testament has been less fruitful, presumably due to the audacity of having Jesus appear onstage. Actual history appears sometimes, as in Putz's *Silent Night*, about the spontaneous truce between German, French, and British soldiers in the trenches of World War I. Mangled history also appeared, as librettists twisted facts (and plagiarized each other) to make dramas more to their era's liking, such as Donizetti's derivative Tudor trilogy.

But the commonest source material is other Western authors. [Simonton \(2000b, p. 110\)](#) listed the Arabian Nights, Ariosto, Beaumarchais, Byron, Cervantes, Corneille, Dante, Dumas, Euripides, Goethe, Gogol, Hoffmann, Hugo, Ovid, Pushkin, Racine, Sardou, Schiller, Scott, Sophocles, Tasso, Virgil, and Voltaire. The most frequently used author is Shakespeare, whose plays have inspired over 250 operas, including those by Adam, Barber, Bellini, Berlioz, Britten, Bruch, Gounod, Halévy, Nicolai, Purcell, Rossini, Smetana, Vaughan Williams, Verdi, and Wagner.

Thus composers and librettists draw from traditions in which they are steeped and also from their own imaginations.

Singers

What do the singers do that is creative? Lyrics and music are given them; the director tells them where to stand and how to act; and the conductor sets the pace. Their creativity consists in making the character their own, skillfully deploying their vocal instruments, and artfully acting the part. Singers learn breath control, technique, transitioning from chest register to head register, and much more – not to mention learning to sing in Italian, German, French, Russian, and Czech.

According to one anthropologist who is also a busy professional opera singer, "Singing is very much like athletics, it's extraordinarily physical It's not just learning the notes and the words. Learning to sing a part in an opera is like learning an Olympic routine as an ice skater" (quoted in [Kotnik, 2008](#), p. 52). And the experience exalts the whole person: when in what Csikszentmihalyi called *flow*, "a performer experiences spontaneous, effortless performance to the exclusion of any internal or external stimuli, whereby body-subject and body-object merge, causing the music to flow out by itself" ([Oakland et al., 2014](#), p. 41).

Career trajectories can be formidably unpredictable. Vocal training for opera can take many years, with no guarantee of even a modest career. At each step, luck (good or bad, meeting the right person, falling ill at a crucial moment) makes a difference. They must resist teachers' urgings to sing higher than they should – too many teachers push mezzos and baritones to become sopranos and tenors, who get the best roles. Choosing the right roles is vital: careers have been ruined by singers accepting assignments that were not fitted for their voices. Damage to voices can also be caused by overwork. Other pressures in the opera life can delay or derail a career: illness, injury, performance anxiety, or an instance of what [Beghetto \(2014\)](#) calls "creative mortification" – a ghastly performance or a savage review.

But those who succeed enjoy a life immersed in the music they love. After their performing careers end, singers can continue being creative, becoming voice teachers, administrators (such as Beverly Sills), stage directors – or creators of their own opera companies, like Irene Dalis, founder of Opera San José.

Conductors

Conductors have an overall conception of the work. They set the orchestra's tempo (speed), dynamics (loud and soft), the emphasis on one instrument or section, the transitions between passages, making the music more lyrical, or more passionate, or more intellectual. Each member of an orchestra plays an instrument; the conductor plays the entire orchestra. Experienced conductors develop recognizable performance styles, and the eminent maestros' recordings may become classics.

Until very recently, women were not afforded the opportunity to be professional conductors. At the beginning of the 21st century, however, numerous women have made strong contributions in eminent orchestras, and practical support for emerging women conductors (and composers) exists in the forms of grants, residencies, commissions, competitions, and positions in conservatories, plus the Women's Opera Network, which supports the advancement of women in opera administration.

Stage Directors

The director's creative contribution is to imagine the opera freshly and to oversee the execution of all things and actions that will be seen on stage. He or she conceives the opera's overall interpretation for a production – whether to present it traditionally, or slightly updated, or wholly transformed by a directorial decision, such as moving Mozart's *Così fan tutte* from the late 18th century to World War I. The director may ask that a key character be interpreted differently, or that unexpected activities be performed by the chorus – or may even invent staging for the overture. He or she directs the movement of singers around the stage ("blocking"), in ways that, ideally, support the text and the music. Good staging can make an opera come to life and give singers a platform worthy of their talents. Eminent directors are those, like Zeffirelli and Ponnelle in the last century, whose productions are treasured and kept in the repertory by numerous opera companies for generations.

Some directors, on the other hand, determined to be thought "original," radically alter the opera. The first scene of *Tosca* takes place in church, where the hero Cavaradossi is finishing his painting of Mary Magdalene. One director decided to place the artist's still-wet painting flat on the floor, and instructed the performers to walk all over it, which they did. Even a non-devout viewer was shocked. Unfortunately, this was one of the milder directorial atrocities of recent decades. In a Canadian production of Handel's *Semele*, the betrothal ceremony was crashed by a two-person donkey, which reappeared during a love scene between Jupiter and Semele, flaunting a giant phallus. In case we were insufficiently repelled, chorus members engaged in nude onstage couplings as well.

These are not accidents. Kotnik (2013) observed that two German directors' stagings are "regularly accompanied by scandals, furors, uproar and sensation" (p. 306). Verdi's *Masked Ball* was once set in a men's room, with the chorus singing while sitting on toilets. Not surprisingly, the style (officially Regietheater, or "director's theatre"), became known in places as "Eurotrash." Even Wagner's own opera house in Bayreuth has encouraged it.

There were loud boos on each night of the opening week and when [German director] Frank Castorf showed his face after *Götterdämmerung*, the crowd howled in anger. The director proceeded to milk the outrage, lingering before the curtain for more than 10 minutes and inserting himself into other people's bows. To all appearances, this finely nuanced performance as Directorial Narcissist was the only characterization to which Castorf had given serious thought.

Ross (2013), p. 71.

Of course, the general directors of the opera companies have a lot to answer for by hiring directors they know are controversial. Admittedly they are trying to win audiences in a challenging environment. Director Peter Sellars said bluntly, "I'm deliberately doing something that we all need to talk about, so controversy is the job description" (Wolfe, 2015, p. C 11).

Luckily, there are dozens of talented directors working today who can successfully stage operas in a traditional fashion, or unleash magical creativity in skilled and tasteful variants. Let us close with the balanced opinion of director-impresario Lotfi Mansouri, who brought the innovation of supertitles to American opera companies: "The most important principle for a stage director to follow is that he or she must remain faithful to the spirit of the work" (Mansouri and Layton, 1982, p. 53).

Administrators

General directors (along with their artistic advisors) select the operas, conductors, stage directors and singers. They hire designers to create sets and costumes under the supervision of stage directors, forming the teams that will bring the vision to life, as much as five years hence. Marketing directors, attuned to the whims of fashion and the vicissitudes of the economy, devise seasonal advertising and long-term outreach.

Creativity is demanded of opera administrators as standard forms of marketing disappear. In the mid-twentieth century, there were three television networks; some featured shows on which opera singers performed for nationwide audiences. Favorable newspaper reviews could fill the house. The loss of these showcases, combined with staggering increases in production costs, means that

at some houses key administrators have come from the business world, not the arts. It remains to be seen how effective this tactic will be in the long run.

Opera companies today must cultivate not just a few wealthy donors, but many donors at all income levels. Opera companies must continually develop new ways to attract ticket buyers and convert them to subscribers. This quest has been assisted by resourceful authors. No fewer than 16 popular books of the 1990s were intended to educate beginners, with titles such as *Get into Opera: A Beginner's Guide*; *Who's Afraid of Opera?*; and, inevitably, *Opera for Dummies*.

But marketing strategies must be carefully considered. Administrators face a daunting task to please the various sectors of their audience. What works in one city may not succeed in another. In places, the opera season may now include perennial favorite musicals and operettas, to the consternation of traditionalists.

Administrators must also decide when to offer revivals instead of funding costly new productions, and attend to such mundane factors as the order in which their offerings are presented. Interspersing conventional and unconventional operas may please audiences but turn off the reviewers. Bundling tickets with various benefits (parking, pre-performance dinners, meeting the singers at special events, etc.) has become an effective way to enhance attendance.

In Europe, government subsidies are common: Germany has 83 opera houses with public funding, while France and Great Britain have about a dozen each. American administrators can only dream of such fiscal stability – but it comes with a price. Lotfi Mansouri remarked, “State subsidies can backfire. The companies can afford new productions and the stage directors feel they have to make their mark. That’s why there’s so much trash onstage” (personal communication, June 18, 2013).

Instead, American companies try creative maneuvers to gain audiences. San Francisco Opera offers an annual free simulcast of a live performance in the nearby baseball park – and as many as 30,000 people attend, bringing blankets and picnics. The youngest children tend to run around the infield, but are nevertheless having that all-important early exposure to opera that helps establish the audiences of the future.

Audiences

To be fully creative, a work of art must reach an audience. This is, of course, especially true in the performing arts. Opera-goers could simply sit passively and absorb the sound and story, but as [Pritzker asserts \(2007\)](#), it is possible to exert creativity even in this limited role. He defines *audience flow* as the experience of viewing a performance or reading a book “in an active and mentally engaged state that may allow insights and new perspectives to develop” (p. 110).

Furthermore, as anyone who has performed even in amateur theatricals knows, an enthusiastic, attentive audience can stimulate them to new heights, while a lukewarm one saps their energy.

Audience members are creative by agreeing to believe that the space behind the curtain is the place it purports to be and that the performers are the people they represent. They don’t care about the classic “three unities” and cheerfully accept each change of scene. They willingly surrender their sense of identity and place, and perform the magic of innocently receiving the musical offering, yet retaining the ability to distinguish their emotions from those being portrayed onstage and to critique the performance afterwards. Of course, they don’t always agree: patrons and reviewers report vastly different responses to the same production, even to the same performance, as attested by the heated discussions taking place during intermissions.

Forman (1994) places opera patrons into five classes: Snobs, who show off their knowledge of opera at every opportunity; Glitzies, who come to display their wealthy social status; Corporates, whose employers demonstrate their philanthropic values with handsome donations; Casuals, the largest group, people who appreciate music and aren’t afraid to show it; and Buffs, the “hard-core opera addicts” – devoted, knowledgeable subscribers who own, read, and listen to books on opera and recordings of operas.

Buffs are passionate fans who seek peak experiences, “collective effervescence,” and “pure musical experience [that] resembles religious mysticism, and ... virtuoso religiosity” ([Benzecry and Collins, 2014](#), p. 307). One interviewee ([Benzecry, 2012](#), p. 45) was annoyed at researchers’ questions that, to him, seemed trivial and irrelevant: “Why is it that you sociologists always ask if I go to the opera to be seen, to meet people, to see my friends, to achieve a better professional status?” he asked. “You always fail to ask me if I go because I like it or, better, because I love it.”

Reviewers

Reviewers have their own form of creativity. The best professional reviewers have had a deep understanding of the art form and some literary skill. Here are a few torrents of eloquence that opera has elicited in the past, starting with an ecstatic review, well worth reading:

Her voice commands overall phenomenal possibilities of expression. She has the profound depth of a contralto and reaches heights of glittering, alluring splendor. From the sweetest-sounding melody into the hollow groan of anguished torture, from the hellish laughter and from the shattering

depths in a siren song of unbelievable beauty ... Her interpretation fills the dimensions of the myth; the measurements of sin and penitence; of the seductress to the ignominious; of inordinate passion and desire finally restrained and subjugated.

Quoted in Riebel (2014), pp. 45–46.

Reviewers can also be uninhibited about issuing caustic takedowns, relishing their power to influence opinion. Wrote another:

Silly and inconsequential incidents and dialogues are daubed over with splotches of instrumental color without reason and without effect, except the creation of a sense of boisterous excitement and confusion ... but even here the expression is superficial and depends upon strident phrases pounded out by hitting each note a blow on the head as it escapes from the mouths of singers or the accompanying instruments.

This was H.E. Krehbiel's opinion in 1900 of *La Bohème* (quoted in Slonimsky, 1953, p. 135). Wagner's third opera elicited this spicy judgment in 1869: "*Rienzi* tastes like a mixture of Verdi and Meyerbeer pounded in a mortar until it begins to ferment" (quoted in Slonimsky, 1953, p. 232).

Reviewers' prophecies can be mortifyingly inaccurate, like this confident judgment: "*Rigoletto* is the weakest work of Verdi. It lacks melody. This opera has hardly any chance to be kept in the repertoire" (*Gazette Musicale de Paris*, 1853; quoted in Slonimsky, 1953, p. 218).

The Future of Opera

With the decline of the subscription base, waning of print newspapers, aging of audiences, and multiple other forms of entertainment competing for audiences' attention, some commentators foresee a bleak future for opera. It is some comfort to remember Rudolf Bing's famous remark, "The opera always loses money. That's as it should be. Opera has no business making money."

However, opera lovers and administrators are rising to the challenge. The Met invented live video broadcasts and reaches millions of people in over 2000 movie theatres in 70 countries. Opera administrators create special social clubs for young people (those under 30, those under 40) to benefit from people's desire to connect outside work. Schools have long been beneficiaries of opera outreach, with many companies sending singers to schools and helping students create and perform their own mini-operas. Teachers eagerly schedule classroom visits by opera outreach programs, and over a hundred opera companies in the United States supply them. This musical collaboration between music professionals and children manifests creativity on many levels, from marketing departments to singers, teachers, and the children themselves.

Today, there are several American opera companies with international stature, half a dozen major regional opera companies, and uncounted smaller companies that provide work for singers and the other opera creators, and music for their cities. According to the trade website Operabase, over 400 opera companies worldwide offer more than 25,000 performances a year. Young singers continue to enroll in conservatories and training programs. Composers continue to offer new operas. Nimble new companies, often founded by groups of singers who perform in modest (even itinerant) venues on shoestring budgets, help extend the passion for opera into the future.

Many opera professionals contend that to remain vibrant, opera must welcome new works. The president of the trade organization Opera America recently wrote, "It is essential that the art form evolve in order to thrive, that we must explore operas that are new in terms of style, subject matter, scale and venue, and that we have to look for many more artists who tell the story of today" (Scorca, 2018, pp. 24–25). Fortunately, many opera companies are doing just that – commissioning works, joining together to pay for new operas, establishing small venues for experimental works, and finding other ways to support composers.

Technology, while presenting stiff competition to opera, also offers opportunities in production and marketing, such as projections, close-ups, live transmissions, promotions on social media, archived online performances, and more. Such flexibility is not mere fashion; cultural historian Kotnik (2013) has found that "the element that ensured opera's long survival has been its adaptability to whatever historical contexts, economic situations, social conditions or cultural milieus surrounded it" (p. 321). Adaptability is, of course, creativity in action. From composers, to administrators commissioning new operas, to technicians taking advantage of new technologies to produce and promote them, to new performers lighting up the stage, to marketing departments dreaming up new ways to attract patrons, to children devising their own operas in their classrooms, creativity in the opera world is flourishing.

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Organizational Creativity

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Introduction

In the management literature, creativity is defined as products, processes, services, or procedures that are both novel and useful (Shalley et al., 2004). What is interesting is that in this literature creativity has been conceptualized in two ways. First, creativity was considered as an outcome, ranging from minor adaptations to radical breakthroughs. As such, scholars using this conceptualization examine the creative performance of individuals and teams. Second, creativity was also viewed as a process, with researchers examining the specific processes that individuals and teams go through while attempting to develop creative outcomes.

Both approaches to creativity (i.e., as an outcome or a process) consider creativity to be a social phenomenon that is influenced by contextual factors. Until the 1980s, psychologists primarily studied creativity as a personality trait or as a cognitive process. However, conceptual work (e.g., Amabile, 1983; Woodman et al., 1993) moved the study of creativity to a more social psychological domain, highlighting the need to consider the external work context.

Amabile's componential model (1983) focused on the social psychology of creativity, arguing that creativity as a trait approach is incomplete, and in fact, creativity can be better understood as a behavior that results from particular combinations of personal characteristics and the work environment. With this model, Amabile highlighted how social and contextual factors were neglected in the creativity literature. She suggested that domain relevant knowledge, creativity relevant skills, and task motivation contribute to creative performance simultaneously and each of these components can be influenced by external contextual factors.

Similar to the componential model, the interactionist perspective proposed by Woodman et al. (1993) emphasized the role of the interaction between individual characteristics and contextual characteristics for employee creativity. Yet, they added another layer to these arguments, and suggested that creativity is a much more complex cross-level system in which individual, group, and organizational characteristics interact with each other. As an example, they suggested that an individual's creative performance depends on the interaction between team characteristics such as group norms, organizational characteristics such as the reward structure, along with individual characteristics, such as their cognitive processes.

Building on these two views, organizational scholars argued that individual characteristics are not the only determinants of creativity, but that the organizational context and the interaction between these two also can play a role in whether employees are creative or not (Shalley et al., 2004). As such, a number of contextual factors that influence creativity have been studied. This entry will briefly review the literature related to five contextual factors that have received the most attention in the management literature as potential antecedents of individual or team creativity. They are leadership, feedback and evaluation, rewards, social networks, and team composition and processes.

Organizational Factors that Impact Creativity

Leadership

To date, leadership is the most widely studied contextual factor impacting creativity. Results of a large number of studies lead to a very consistent finding that leadership positively relates to creativity as long as it is supportive and noncontrolling. This is true for a wide range of different leadership styles, such as transformational leadership, servant leadership, and ethical leadership, among other leadership styles. For example, some researchers developed and tested a model linking empowering leadership with both creative process engagement and creative performance and they found that empowered leadership positively affected psychological empowerment, which in turn influenced both intrinsic motivation and creative process engagement, and ultimately creative performance (See Leadership).

Employees with creative personalities who worked on complex jobs, and had supportive, noncontrolling supervisors had the highest creative performance. Instead of focusing on a specific leadership style, [Koseoglu et al. \(2017a\)](#) examined the role of the supervisor's own level of creativity on employee creativity. They found that subordinates' creative role identity (i.e., whether being creative is part of your work identity) is an important underlying mechanism in the relationship between supervisors' level of creativity and subordinates' creativity, and their results supported this. Research investigating the dark side of leadership for employee creativity suggests that not only can leaders' abusive supervision negatively relate to their employees' creativity, but that it can also have a cascading effect and flow down levels in the organization, undermining team members' creativity.

Feedback and Evaluation

Although there have been some conflicting empirical results, in general the common wisdom is that the effect of evaluation and feedback on creativity can be positive as long as the message conveyed is more informational than controlling. For example, [Shalley and Perry-Smith \(2001\)](#) found that the creativity of individuals expecting a judgmental evaluation was significantly lower than those expecting a developmental evaluation.

More recently, some interesting approaches examined the impact of evaluation or feedback on creativity. For example, [Yuan and Zhou \(2008\)](#) investigated the differential effect of expected external evaluation on two different stages of the creative idea production process, idea generation and idea selection/modification, and found that expected evaluation had different effects on these two stages. Specifically, during idea generation those who expected an evaluation generated a fewer number of ideas, while during idea selection/modification, those expecting an evaluation performed better in improving the idea's appropriateness. Furthermore, individuals who only expected an evaluation during the idea selection/modification stage produced the most creative ideas. [Harrison and Dossinger \(2017\)](#) explored how feedback seekers and providers in creative work find a balance between what makes feedback helpful and having the freedom to explore new ideas. They found that when seeking feedback, individuals that were more curious tended to ask more open questions, allowing them to gain more information. They also found that ambivalent feedback lead to higher acceptance of the comments, and ultimately design revisions.

Rewards

The effect of rewards on creativity has received much research attention, and most of this work has been conducted in the laboratory. However, the empirical results are typically mixed and inconsistent. While some studies found that rewards detrimentally effect creativity, other studies have found them to have a facilitative effect. In addition, there has been a great deal of controversy regarding the likely direction of the effects of rewards that are contingent on creativity. For example, [Amabile \(1983\)](#) argued that rewards contingent on being creative can serve to control individuals' behavior and lead to lowered intrinsic motivation and creativity. Others argued that rewards can have informational value and can signal personal competencies, and therefore facilitate creativity (e.g., [Eisenberger and Rhoades, 2001](#)). There is still an ongoing debate in the literature, with different studies supporting each position (See Rewards and Creativity).

Results of a meta-analysis suggested that the above conflicting findings could be due to differences between studies in terms of reward conditions and the context in which the reward is offered ([Byron and Khazanchi, 2012](#)). Specifically, across approximately 70 studies, rewards tended to increase creativity especially when individuals were aware that the reward was contingent on creative performance. In addition, some researchers suggested that the relationship between rewards and creativity can be contingent on cognitive style and job complexity. Specifically, researchers found a positive relationship between rewards and creativity for employees with an adaptive cognitive style who worked on relatively simple jobs. In contrast, they found a weak relationship between rewards and creativity for employees with an innovative cognitive style who worked on complex jobs, and a negative relationship for those who had an adaptive style and worked in complex job and those who have an innovative style working in simple job conditions (See Cognitive Styles).

Social Networks

Since employees do not work in isolation, their relationships with others in the organization can impact their creativity. Therefore, another contextual factor, the social networks of employees, was examined. Researchers found that an employee's strength of network ties (i.e., the closeness, duration, and frequency of the relationship between two actors which can range from weak to strong) and the structure of his/her network (i.e., the configuration of how one's contacts are connected to him/her and to each other) impacted his/her creativity. Researchers who focused on the characteristics of network ties primarily examined the role of tie strength, and there were conflicting results. For example, having a large number of weak relationships was found more beneficial for collecting a diverse set of non-redundant information and perspectives from various contacts rather than investing in fewer but stronger relationships ([Perry-Smith and Shalley, 2003](#)) since individuals have limited time and resources. On the other hand, other researchers suggested that strong relationships are more beneficial for creative performance, because gathering information from people necessitates a sense of trust and cohesiveness. Integrating these two opposing views together, some researchers argued that the importance of strong versus weak ties depends on the stage of the creative process. For instance, while a higher number of weak ties can facilitate idea generation, a higher number of strong ties can be beneficial for idea elaboration.

The second network characteristic that impacted employee creativity was network structure. Researchers studied either the local network of individuals, that only includes their immediate contacts (i.e., ego networks), or their global network, which is their position in the entire organizational network. The local network structure of an ego network can vary in its level of density. Burt (1992) introduced the importance of brokering structural holes that deal with whether one is connected to two individuals who are not connected to each other. If an individual has a lot of structural holes in his/her ego network (i.e., contacts who are not connected to each other but only connected to the ego), this is considered to be a “sparse” network with lower density. In addition, the more the contacts of an individual are already connected to each other, the fewer structural holes in his/her ego network and the network becomes denser.

Just like the tie strength arguments, there is an ongoing debate on the role of network density for employee creativity. The benefit of serving as a bridge over a structural hole and connecting two unconnected contacts is in getting non-redundant information and diverse perspectives from both contacts that have been found to facilitate creativity (Burt, 1992). An individual with a sparse network structure may have the opportunity to collect a great deal of diverse and non-redundant information, and therefore have higher creative performance. Another group of researchers claimed that closure within a network results in trust-based relationships that enhance information transfer among actors. These researchers stated that the trust and reciprocity provided by dense networks make diverse information more accessible due to enhanced cooperation and collaboration, since individuals will feel safer sharing their opinions in their work environment, which can eventually lead to better creative performance.

Some studies combined these two conflicting arguments, looking at the entire innovation process. For example, some researchers found that sparse ties can be advantageous during the creative process, but when it comes to the diffusion of those ideas and moving through to innovation, it is better to have dense relationships. Another group of researchers studied the innovation process under three stages: idea generation, development, and refinement. They found that density should increase in each stage, starting from idea generation through idea refinement. Meta-analysis findings suggest that network density has negative effects on employee innovation, and brokerage has the strongest positive effect compared to the effects of tie strength, network size, and diversity (Baer et al., 2015).

When it comes to an individual's location in the global network structure, in their conceptual piece Perry-Smith and Shalley (2003) argued that employees in a peripheral location who have a higher number of connections outside of the organizational network are more creative because they have access to non-redundant information that is not shared by others in the organization. Yet, they also argued that as a person performs creatively, their popularity in the organization increases, and this can cause them to move from a peripheral position to a more central position over time. Other researchers further found that the most creative individuals were at an intermediate position between the center and the periphery because each position has different benefits. For example, while being close to the center can help with getting one's creative ideas recognized and implemented, peripheral locations provide access to outside organizational contacts with non-redundant information.

Team Composition and Team Processes

Although working alone can enhance creativity, in organizational settings, employees typically work in teams. Therefore, it is essential to understand how teams can be creative, but to date the organizational creativity literature is still predominated by studies on individual creativity.

Team creativity is a collective phenomenon that involves members defining problems, generating ideas, and attempting new ways of solving the problems they face at work (Gilson and Shalley, 2004). As such, although the average of each team member's creative performance and the team's overall creative performance has a positive relationship, team creativity is not just simply an aggregate of individual creativity. Rather, team creativity is a function of the interaction between team members and the contextual environment in which they work Woodman et al. (1993). Similar to individual creativity, team creativity also can be considered as an outcome or a process. Research examining antecedents of team creativity found that both team composition and team processes can influence team creativity.

Perhaps the most frequently studied team compositional characteristic is team diversity. There are two types of diversity, deep level diversity (or cognitive diversity) which is based on non-observable differences among team members such as functional background or abilities; and surface level diversity based on observable characteristics such as demographic differences. The research indicated mixed findings on the relationship between deep level diversity and team creativity. On the one hand researchers found a positive relationship, arguing that a greater range of perspectives, ideas, and abilities result in higher quality solutions. On the other hand, some researchers found that conflict, which can be an outcome of diversity, can hurt team creativity due to a lack of information sharing among members. Some researchers added that conflict had a stronger impact at earlier stages of the team life cycle and could become irrelevant at later stages. In order to explain these contradictory findings, van Knippenberg et al. (2004) adopted the categorization elaboration model of diversity, suggesting that task diversity will be beneficial for team creativity only if team members can take advantage of this diversity. For example, researchers found that team diversity had a positive impact on team creativity as long as team members took advantage of diversity by engaging in perspective taking, as this lead to the successful elaboration of the diverse information held by each team member. Relationship conflict based on interpersonal incompatibilities among team members, could be an output of surface level diversity, and lead to a lack of information exchange between team members. Therefore, research showed that surface level diversity negatively impacted team creativity.

Meta-analytic evidence suggested that goal interdependence is one of the strongest antecedents of team creativity, meaning that teams with a common goal of being creative are the most creative. Relatedly, it was found that teams with high goal and task

interdependence were more likely to engage in creative processes. Another critical team compositional factor is team size. Having more members can potentially lead to more diverse information, resulting in higher levels of team creativity, yet communication problems and social loafing can arise due to the larger team size, impeding creativity. Focusing on innovations in the comic book industry, researchers found that having a higher number of creative team members affected the variance of a product's innovation, with the outcome being either extremely creative or extremely non-creative.

Team processes also play an important role for team creativity. Team members who shared knowledge and ideas were able to make new connections between previously unconnected ideas. Team learning which involved behaviors such as feedback seeking and reflecting on previous results played a critical role in team creativity.

A series of laboratory experiments suggested that when teams learned from their own experiences, they became more creative as they kept working as a team on new tasks. This relationship was mediated by developing a transactive memory system, which is defined as a collective learning and memory system used to encode, store, retrieve and communicate group knowledge. Furthermore, teams with prior experience working together generated outcomes that were more creative since they had an easier time communicating with each other. However, collaborating repeatedly as a team can start to hurt team creativity if the members stop focusing on their differences in ideas and perspectives and become more stable. In order to overcome this possibility, new team members could be added to the team or interventions could be used. Yet, it should be noted that the timing of these interventions could play a role as well. For example, deadline changes at the very last minute, or workload changes any time after the mid-point of the original assigned task time can be detrimental to team creativity (Koseoglu et al., 2017b) (See Teams).

Concluding Remarks

In the field of management, a number of studies examined the effect of contextual factors on employee creativity, such as leadership, feedback and evaluation, rewards, social networks, and team composition and processes. However, there is still a need for more work in this area. In particular, there is still not a full picture of how these five contextual factors influence employee creativity. In addition, there are many contextual factors yet to be examined in any systematic way, as well as their potential interaction with different personal characteristics to impact employee creativity.

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Paracosms

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Glossary

Fanfic A variety of literacy practices, including producing short stories, poetry, lyrics, and fantasy worlds, among others, that express identification with a fandom community.

Juvenalia Artifacts of childhood, often including toys, games, and products of creative engagement, such as written stories and childhood art pieces.

Paracosm A consistently maintained, and often deeply cared for, personal imaginary world created during childhood or early adolescence. The act of creating and maintaining a paracosm is sometimes referred to as “worldplay.”

Transnarrative A story that exists separately from any one media presentation, and as such may be engaged with through multiple venues, including movies, books, games, and online discussions.

World-building The process of constructing a fictional world as a setting or as a creative product in itself. World-building can be a solitary activity or the object of social collaboration. It is sometimes related to fan fiction writing.

Introduction

There is a lonely sort of splendor to be appreciated in the fantasy worlds of childhood, when the capacity for mythical thinking burns at its very brightest. The curious and imaginative sometimes develop raw and elegant demonstrations of the human potential to envelop the whole of humanity’s limited experience in a sense of abiding wonder.

It was in an effort to preserve these nostalgic treasures, to capture imagined vistas like “flies in amber,” that retired BBC producer Robert Silvey and retired psychiatrist Stephen MacKeith set out, in the latter days of the 1970s, to collect and categorize the personal accounts of roughly five dozen individuals who still remembered with intensity the worlds they had invented as children (Silvey and MacKeith, 1988, pp. 173–175). This was the first study of the paracosm initiated.

From the very beginning this research was unusual. It was not the result of an ambitious young scholar nor the product of an established developmental psychologist. Instead, it was a deeply personal, heartfelt attempt on behalf of an elderly, educated, and arguably amateur researcher to simply locate others in the world who shared his enthusiasm for the imagination of his childhood (Cohen and MacKeith, 1991, pp. 11–14). So, rather than early stories of pilot studies and participant sampling, there are tales of Silvey’s expository letters posted in *The Author* and the *Observer* (Silvey and MacKeith, 1988, p. 175). And, rather than making arguments for generalizability of their findings and emphasizing the broad applicability of the work, the authors made statements about how limited and private their findings were (1988, p. 177), going so far as to later warn parents away from discussing suspected paracosms with their children (Cohen and MacKeith, 1991, p. 23).

However, in seeking to gather the first paracosms, Silvey’s study called to inquiry a topic which had been theretofore largely elusive in our understanding of the development of the imagination, and which, at some level, contradicted established notions of childhood cognition (Cohen and MacKeith, 1991). He also set the tone for the emotional character of the work, which still bears the markings of attention to care, respect, admiration, and deep connection through imagination, such that even when reading

modern paracosmic accounts like those of Root-Bernstein's *M* (see [Root-Bernstein, 2009](#), pp. 601–602), it is easy to comprehend from the beginning that the unnamed participant was not treated as a random encounter, but rather like someone that the author had a close relationship with. (And indeed, *M* was revealed in later writings to be Root-Bernstein's daughter Meredith [[Root-Bernstein, 2014](#), pp. 3–4].)

This is significant because not all paracosms have been described by living persons. Indeed, some of the most famous examples of paracosmic imagination have been taken from biographical accounts and historical documentation of socially, intellectually, or artistically eminent individuals, including C.S. Lewis, Christopher Isherwood, and Friedrich Nietzsche ([Silvey and MacKeith, 1988](#), pp. 191–194). And yet, that feeling of intimacy—of a shared implicit understanding communicated through a mutual reverence for the imagination—prevails. In the introduction of [Wolf's \(2012\)](#) book, for example, the author made an argument for the intensity and emotive power that imaginary worlds can command in the experience of those who have created them, noting that “L. Frank Baum's last words on his deathbed were reportedly ‘Now we can cross the Shifting Sands’.” The tombstone for J.R.R. Tolkien and his wife Edith contains their own names as well as those of Beren and Luthien” (2012, p. 5). Wolf then, in a manner that is highly characteristic of this work, reflected on the role of imaginary worlds in his own life, recounting early experiences with LEGO and animation, as well as how he was drawn to the imaginary worlds of sci-fi and fantasy from a young age (2012, pp. 5–6).

Still, it is not in reverence alone that paracosm research has endured. A constant complement to the work of gathering new accounts of imaginary worlds is a desire to answer questions about their influence and meaning. Various approaches comprise separate branches in paracosm research, following a loosely historical pathway from the formative era of the 1980s to later divergences encompassing both paracosm investigations from the vantage of creative research and transnarrative studies. In the following sections, each of these three approaches will be discussed, highlighting their efforts to contextualize the paracosm from various social and ideological positions, as well as their contribution to overall understanding of the paracosm as a unique force in the lives of certain creative individuals.

Formative Studies of the Paracosm

As mentioned previously, the origin of paracosm research as it has been conceptualized in the modern era was to be found in the writings of [MacKeith \(1983\)](#), [Silvey and MacKeith \(1988\)](#), and [Cohen and MacKeith \(1991\)](#). Prior to this, there had existed a small, but not inconsiderable, body of literature dedicated to preserving certain childhood imaginings as a form of bibliographic juvenalia, showcasing the most noteworthy artifacts of a deeply personal type of youth literature. These paracosms tended to date no further back than roughly the late 1700s, with the earliest recorded historical paracosm belonging to Thomas de Quincey who was born in 1785 ([Silvey and MacKeith, 1988](#)). Many of these imaginary worlds were, by virtue of the zeitgeist in the era of their construction, strongly inspired by British colonialist ideologies and were contextualized by elements of imperialism, social hierarchy, and exoticism (see [Harty, 2007](#) for discussion).

This is made clear when one considers the details of C.S. Lewis's imaginary worlds of “India” and “Animal-Land,” for example, or his later world of “Boxen” which were rife with mixed “medieval and Victorian trappings” and led by a frog named “Lord Big” ([Root-Bernstein, 2014](#)). These ideals are also easily found in the shared worlds of the Brontë siblings, “Glass Town,” “Angria,” and “Gondal,” which were full of the children's shared interpretations of changing social, scientific, and moral ideals which had been inspired by their well-read upbringing, and which shaped their later works in a myriad of direct and indirect ways ([Cohen and MacKeith, 1991](#)).

There is even cause to believe that the social changes of Victorian era might, in themselves, have been a catalyst for the rise of paracosmic imaginings. [Harty \(2007\)](#) argued that emergence of the Victorian paracosm was likely the consequence of the concurrent rise of colonialist policies of the Western culture, the development of literary Romanticism, and the production of fantasy stories aimed at children:

In the second half of the nineteenth-century, the cultural agenda shifted, and paracosms were consequently relocated. Continuing the Romantic discourse of childhood, expanding and emphasizing its Neverland quality, during the Victorian era, a “golden age” of children's literature, the paracosms imagined by children were converted by adults into texts for children. [...] Through Romanticism's mapping of childhood, it became an island, a space apart. This map was subsequently internalized. Victorian childhood became an island embedded within the child

[Harty \(2007\)](#), pp. 232–233.

As illuminating as the Victorian perspective offered through lens of children's imagined worlds might be, however, it is important to note that in his first article, [MacKeith \(1983\)](#) made only a passing mention of his selection of historical paracosms, emphasizing instead the private worlds he had collected from ordinary people in his contemporaneous participant population. It was only later that [Silvey and MacKeith \(1988\)](#) included written summaries of these accounts, reasoning that “evidence from literary sources” would benefit paracosm research, in part, because “Almost all of [the historical paracosmists] became famous, or at least well-known. The ordinary reader already knows something about their later lives, and has easy access to further information about them” (1988, pp. 190–191).

By incorporating historical accounts of paracosms into their research in this manner, [Silvey and MacKeith \(1988\)](#) appeared to have been making an appeal to eminence—specifically the literary eminence associated with celebrated writers, poets, and thinkers

of that era—and incorporating the notion, more or less explicitly, that creating the paracosm may be an influence on later literary acclaim. As such, in their choice to examine the personal records of imaginary worlds present in the biographical histories of famous writers, [Silvey and MacKeith \(1988\)](#) were, as a corollary, appealing to the social position of the authors to help convey a sense of the value of the paracosm. In so doing, they appear to have systematically adopted reference to eminent imaginary worlds as an essential facet of paracosmic research.

Indeed, almost no later study or account of paracosmic imagining exists without some reference to this appeal to an eminent paracosm (cf., [Root-Bernstein, 2014](#); [Wolf, 2012](#)), which is ironic given that the early intention of the research was to serve as “a rich source for understanding how children’s imaginations can work and can develop among those who don’t go on to make glittering creative careers” ([Cohen and MacKeith, 1991](#), p. 22). Even so, given their persistent, overriding goal of cataloging paracosms ([MacKeith, 1983](#), p. 263; [Silvey and MacKeith, 1988](#), p. 174; [Cohen and MacKeith, 1991](#), p. 22), this digression into historical paracosms remained logically consistent, as it was, in some sense, just another corpus to be utilized in the refinement of a classification method—and, in fact, historical paracosms were ordered alongside others in [Silvey and MacKeith’s \(1988\)](#) study.

And it was in this way, more generally, that much of the formative paracosm research functioned. Paracosms were collected and they were categorized, with attention given to underlying questions of how paracosms fit together and relatively little concern for why they came about. As such, multiple classificatory systems were developed, each with varying degrees of relevance to the organization of material and dimensions of personal expression. These included a group of paracosmic accounts by theme ([MacKeith, 1983](#), p. 265) which later ordered their whole contemporaneous sample of paracosms ([Cohen and MacKeith, 1991](#)), the thematic characteristics of the paracosmic play, identified as four underlying “dimensions” ([Silvey and MacKeith, 1988](#), p. 185), and the personality characteristics of paracosmists, which were determined by the frequency by which participants endorsed adjectives that they believed identified themselves ([Silvey and MacKeith, 1988](#), p. 187).

Additionally, and most contentiously, [Cohen and MacKeith \(1991\)](#) presented a completed classification system which culminated the age- and development-oriented theories first proposed in [MacKeith \(1983\)](#). This developmental schema of paracosmic imaginings located paracosms relative to other types of imaginative content ([Cohen and MacKeith, 1991](#), p. 109) and expressed according to age groups in terms of their likelihood of engagement by group, with ages ranging from 3–18, wherein there was increasing occurrence of paracosmic play into late childhood and early adolescence, peaking around age 9 ([Cohen and MacKeith, 1991](#), p. 110). In so doing, they made plain their awareness that this organization of evidence would contravene established theories of the development of fantasy play ([Cohen and MacKeith, 1991](#), pp. 14–16), which had theorized that normal fantasy play should come to a close around age 7, and should not continue at all into adolescence. This is particularly noteworthy for the reason that this research presaged the more recent work of researchers like [Smith and Lillard \(2012\)](#) wherein there would accumulate a significant amount of evidence, via retrospective reporting, to support the position that fantasy play could continue beyond late childhood.

So, what to make of this rambling history of the formative study of paracosms? Perhaps it is this: That the studies of [MacKeith \(1983\)](#), [Silvey and MacKeith \(1988\)](#), and [Cohen and MacKeith \(1991\)](#) had their greatest impact by creating precedent for works to follow. In consequence of their desire to cast a wide net, researchers in this strand sought out all paracosms that were available to them, incorporating both contemporaneous and historical accounts. In so doing, they anchored understanding of the historical paracosm to the Victorian ideologies which pervaded written childhood accounts—that paracosms were exotic places, often to be mapped, which could give rise to fabulous romantic cultures and individuals. At the same time, their appeal to eminent paracosms connected this work inexorably, if perhaps unintentionally, to evocative elements of creative genius and, implicitly, to the potential development thereof. Finally, efforts to systematize paracosms according to characteristics of the imaginary places themselves, and the people who bore them, set the standard for discourse about paracosms—that they were to be defined on the basis of their contents and explored relative to their role in aspects of human development, most especially those of fantasy play and the creative imagination.

Studies of the Creative Paracosm

Starting with the work of [Robert Root-Bernstein and Michelle Root-Bernstein \(2006\)](#) and continuing in the writings of [M. Root-Bernstein \(2009, 2014\)](#), there was a revival of the study of paracosms which hewed to the overarching notion that the creation of paracosms, or “worldplay” ([Root-Bernstein and Root-Bernstein, 2006](#), p. 405), could be a sign of exceptional creativity and could, through engagement and participation, serve as a facilitator of creative thinking.

Across this strand of research, it would be difficult not to credit the appeal to eminence found in earlier, formative studies of the topic as a fundamental motivation for the work: Prior to taking up paracosms, one area that had attracted the Root-Bernstein’s attention was the way that imagination, playfulness, and creative thinking influenced highly successful and award-winning scientists (see, for example, [Root-Bernstein and Root-Bernstein, 1999](#)). And it was arguably the intention of the authors to rebut the putative status of the paracosm as it had been understood through the turn of the new millennium in those very first studies—that is to say, they were rebuking the interpretation of paracosms as primarily the product of the imagination of ordinary people (as in [Cohen and MacKeith, 1991](#)).

As such, [Root-Bernstein and Root-Bernstein’s \(2006\)](#) method of investigation followed from the creation of a survey to identify the prevalence of paracosmic imagining based on criteria provided in [Silvey and MacKeith \(1988\)](#) and [Cohen and MacKeith \(1991\)](#) that was then offered to individuals in two participant sample groups: In the first case, the survey was completed by young adults

attending courses at Michigan State University (MSU), and in the second case, the survey was offered to recipients of the prestigious MacArthur Fellowship, an award given by anonymous nomination to individuals with “extraordinary originality and exceptional promise” (Root-Bernstein and Root-Bernstein, 2006, p. 407). Group comparison data demonstrated that engaging with paracosms was nearly twice as common among MacArthur Fellows (a prevalence rate of 5%–26%, based on criteria restrictions) when compared to MSU students (a prevalence rate of 3%–12%) (2006, pp. 409–411).

Later works contextualized these findings, developing the position that paracosms were indicators of early creative giftedness and that they might, more so, serve as means for the facilitation of adult creativity—as made plain in Root-Bernstein (2009), wherein the author stated:

This re-evaluation of childhood worldplay in terms of adult creative endeavor sets aright certain misconceptions of worldplay in earlier research. Among adults recognized for creative giftedness, worldplay may, at a maximum, figure in childhood play in as many as one out of four. [...] The enduring benefit to adults of childhood worldplay does not lie necessarily or only in an early immersion in technical skills such as writing or drawing. It lies, as well, in the early immersion in self-prescribed “learning laboratories,” in self-taught creative behaviors and in self-nurtured attributes of creative personality

Root-Bernstein (2009), p. 608.

It is important to highlight here that the argument for the inherent creativity of worldplay activities represented a dramatic shift in the representation of the paracosm: Hereafter, they were not cast as the unusual product of a certain trajectory in the development of childhood fantasy play (as in Cohen and MacKeith, 1991, pp. 107–111). Instead they were thought to serve a purpose in the development of the creative imagination, and that a meaningful act of creating fantasy worlds could be capitalized on in such a way as to potentially improve creative performance, and, as a corollary, fundamental thinking skills necessary for innovation among all children (as in Root-Bernstein, 2014).

This idea has since found resonance with advocates who promote the importance of play and imagination as vital components in cognitive development for the sciences. Osterblom et al. (2015), for example, have utilized the paracosm as an exemplar of the capacity of great scientific thinkers to seek alternatives to orthodox worldviews, arguing that “the bedrock of creativity, among both artists and scientists, is the questioning and challenging of perceived reality and received wisdom” (2015, p. 16). They argued that paracosms can serve as a vehicle to embrace that challenge. Likewise, Russ’s (2016) article on the topic of the development of adult creativity drew a similar connection between paracosmic play in childhood and the expression of artistic and scientific creativity in adulthood, indicating that the mental states of paracosmic play tended to echo those of adults engaged in creative activities.

More broadly, the arguments for “playful learning” presented in Root-Bernstein’s (2014) book promoted a systematic inclusion of paracosmic imagining as a complement to educational activities. This effort highlighted the experiences of Deborah Meier, whose work in education, she believed, emulated the story and structure of paracosmic imagining (2014, p. 159), as well as accounts of more direct attempts to include imagination, play, and paracosmic world-building into school curricula through efforts like those of Richard Murphy and his *Imaginary Worlds* experiment (2014, p. 162).

And yet, even in spite of the opportunities that these methods might hold as means of improving education, there are causes to moderate expectations for the types of outcomes that a paracosm or imagination-based curriculum can produce. In their (2018) study, Taylor, Mottweiler, Aguiar, Naylor, and Levernier returned to the practice of gathering contemporaneous accounts of paracosms; however, in this case, the researchers mitigated the possibility of retrospective bias by interviewing children ages 8–12. Across their related studies, Taylor et al. (2018) investigated multiple indicators of creative thinking using a variety of assessments, measuring creativity in a diverse manner. They also assessed indicators of the cognitive states and capacities of their participants, including a coping strategies assessment, an inhibitory control assessment, and a receptive vocabulary measure. Their findings indicated that paracosmist children were more likely to display a greater proclivity toward creativity in measures of story-based creative thinking, but—most importantly—their participants displayed no other stable pattern of performance differences among other indicators of creative thinking.

This later evidence against a generalized benefit to creative thinking provided by the act of paracosmic play has, in effect, set a higher standard for future work that would hope to cast worldplay as a meaningful contributor to innovation in the arts and sciences. It supports the implication that future exponents of the educational value of the paracosm must contend with possibility—as Lillard et al. (2013) have articulated—that researchers who take up topics in areas of fantasy play and imagination should take care not to unintentionally bias their results to favor the causal efficacy of fantasy play, operating under assumptions which afford a privileged position to the “power of play” in support of a positive “play ethos” (2013, p. 4). How future researchers who seek a deeper understanding of the paracosm from the worldplay perspective will accommodate methods that incorporate more rigorous, systematic data collection and analysis procedures will doubtlessly influence the character of further research.

The Social Paracosm

The research perspective articulated in this final section does not have a definite series of active proponents, nor does it emerge from a disciplined selection of criteria for the developmental conditions or cognitive utility of the paracosm; rather, it is inspired by an assortment of findings which contradict the social role of the paracosm as it was originally envisioned. Initially, Cohen and

MacKeith (1991) set the precedent that paracosms were “private worlds of childhood”; that a paracosm was often, though not exclusively, the product of a single young person, or shared by a few siblings (1991, p. 38). So, what to make of findings demonstrating that nearly 40% of paracosmists share a world with other people (Taylor et al., 2018)? And, more to the point, what might paracosmic play look like if it could be conceived of as a social medium?

Although there has yet to be an empirical investigation constructed such that the social role(s) of a variety of shared paracosms across childhood contexts have constituted the sole topic of a study—a condition which may limit the generalizability of our current understanding—it is worth attending to the framework by which authors like Wolf (2012) and Angles (2018) have oriented the essential notion of the shared paracosm in the wider space of the development of imaginary worlds as a human endeavor. Wolf (2012), for example, incorporated paracosms into his synthetic concept of “sub-creation” with little hesitation, invoking the act of “world-building” as an intermediary, then accepting wholesale that paracosms, as imaginative world-building activities, were examples of sub-creation. Similarly, Angles (2018) broadly integrated themes in the storytelling and fantasy world-building aspects of paracosmic play to develop tactics that would allow for “imaginative explorations of, and design for speculative environments, in response to, and preparation for, challenging situations” (Angles, 2018, p. 4).

Unlike the case for extant paracosm research—focused largely on solitary fantasy play—research into activities related to world-building have a clear connection to topics of social organization, social identity development, and the interactive role of participants and presenters. World-building activities can take a variety of forms, ranging from the world creation which frames live-action role-playing, tabletop roleplaying gaming, alternate reality gaming, and the creation of constructed worlds for the purposes of fiction writing. They are the basis for many activities by which individuals express their interest in fantasy in a social setting, utilizing their ability to take up roles in an established fantasy world as a means of self-expression and creative engagement, some of which include the writing of fan fiction and fan art. While not explicitly limited to a single culture, context, or way of life, there is a greater tendency to experience these kinds of activities more often in Geek culture venues due to the fact that passionate interaction with fiction is a common avocational occupation among people who identify with that subculture.

It is important to note that interaction with fantasy through world-building activities is not limited to real-world venues, nor to one particular form of expression. World-building is mutable, transcending a single medium or mode of interaction. These sorts of fantasy-based creative activities embody the concept of “transmedia storytelling” (Jenkins, 2007) in which any specific media format serves as one of many “windows” to access the “world” that is the true “object” of an individual’s interaction with the fictional narrative (Wolf, 2012, p. 247). In this way, a richly realized imaginary world, paracosms or otherwise, might reflect incorporation of—and engagement with—the many fantasy worlds prevalent in modern society which are increasingly characterized by their capacity to encompass many sources, a variety of tellings, and different media formats.

Thus an interested individual could easily find multiple avenues of fantasy interaction with the fictional world of *Harry Potter*—as just one of many examples—via roleplaying forums on Discord (see “Harry Potter RP”, 2019) and fan fiction writing circles (see “Harry Potter Communities”, 2019). This contributes to the notion that any young person interested in the world of *Harry Potter* could meaningfully invest their time, passion, and imagination to the creation of a personal interpretation of the world of *Harry Potter* that would be functionally indistinguishable from the paracosms recorded in the early literature: The interpreted world could contain novel creations in location, substance, orientation, and social interaction, being wholly or partially the independent expression of a single, individual young person’s imagination. And yet, because of the transmedia nature of the *Harry Potter* world as it now exists, it is possible for young people to go further with their creation if they should so choose, and conveniently share, their private imaginary world with others in ways that might allow them to also contribute to the evolution of a collective imagining of the world with others, bridging individual paracosms through the social act of world-building.

And so, what might be the implications for adopting the transmedia perspective as a future venue for paracosm research? This is, at present, unclear. However, there appear to be enough similarities between the shared paracosm and other forms of transmedia storytelling to hazard some early questions: First, if one accepts that some paracosms may be shared among individuals and that others may be constructed by an individual just for themselves, does this imply two distinct uses of the paracosm? Or might there be a continuum of paracosmic social engagement? Do individuals inclined toward the social paracosm experience the development of fantasy play differently than those who have experienced a solitary paracosm? Might there be a cultural or ideological agent (possibly, for example, an inverse of the play ethos) that would inhibit social paracosmic play? And, furthermore, might it be assumed that there could be variance in the developmental impact of shared versus solitary paracosmic play? Does, for example, social paracosmic play naturally extend into a tendency to engage with other forms of transmedia storytelling in adolescence and adulthood? It is hoped that future researchers continuing in this framework might be able to approach some or all of these questions and provide some greater insight into the, as yet, poorly understood social world of contemporary paracosmists.

Conclusion

Nearly half a century has passed since Robert Silvey first set out to explain the imaginary world that had so occupied and enriched his own childhood. Since that time, much has been learned about these paracosms—their affective character, their duration, their development, and the central role that they can play in the lives of young people are a few significant insights. Based on the empirical work of Robert and Michelle Root-Bernstein, there is a perspective that the paracosm is related to learning, cognition, and intellectual giftedness, and that, furthermore, it is possible to utilize the paracosms itself as a medium for facilitating meaningful instruction. Historically, these insights have constituted the majority of research available on the topic of private solitary worlds

of childhood, and while the perspectives differ in a few key ways, both the work of Silvey and the Root-Bernstein remains the foundation to help understanding of this type of unusual imaginative activity.

Even so, there remain a number of unanswered questions yet to be addressed by research, not the least of which is the proposition that the social nature of world-building—a method of engaging creatively with fantasy that has grown along with the spread of transmedia narratives—may influence (and be influenced by) the formation and expression of individual paracosms. With the advancement of communication technology and the expanding cultural significance of sophisticated fantasy and sci-fi settings, it appears possible that the experience of solitary paracosm as it had existed in previous times, and which was so keenly felt by Silvey throughout his life, may be evolving in ways that could not have been predicted in prior eras: Thus, perhaps, it could be said that the notion of the 21st-century paracosm has, in itself, become an unexplored frontier on the horizon of imagination.

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Paradoxical Creativity

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Introduction

Creativity can be analyzed through various psychological dimensions. Personality is one of the earliest and most prominent approaches. The extensive study on creative personality has documented two main theoretical perspectives. The first is the classical approach that focuses on fixed traits or dimensions (Domino, 1970; Gough, 1979). To test the usefulness of this approach, researchers collected data from people in certain occupations. They examined if personality attributes may explain how some individuals are more creative than others within a certain domain. Those studies indicated that creative people tend to be autonomous, independent, contrarian, non-conformist, and challenging the status-quo.

On implication of such conceptualization of creative personality is that some of those characteristics may be the characteristics of people with mental illness or those having the propensity to develop one. In fact, the link between creativity and mental illness attracted much attention. Specifically, creativity has been studied among psychotic patients and occasionally found to be linked to pathological traits (Eysenck, 1995). Although there is evidence for creativity's relevance to psychoticism, the vast majority of researchers tend to study creativity's relationship with non-pathological traits such as adaptability, sensitivity, originality, receptivity, perseverance, independence, tolerance towards frustration or uncertainty, openness to experience and self-discipline (Guilford, 1950).

The second approach is based on the paradigm of complexity and focuses on the dynamic coexistence of opposing tendencies (Csikszentmihalyi, 1996; Torrance and Hall, 1980). Creative personalities are defined as having the ability to modify one's own actions by embracing contradictory attitudes. From this perspective, creative people have a "paradoxical personality".

Paradoxical Personality

Human beings originally possess multiple contradictory qualities. However, these qualities either become fixed or weakened as they develop. Once weakened, only one pole of the contradiction will be expressed and turned into a particular personality trait. Therefore, a large majority of people do not have both poles or exemplify the notion of coexistence of paradoxical tendencies and thoughts. They are usually considered as either conservative or rebellious, passionate or objective, humble or proud, not both. Creative people, by contrast, usually retain both poles and express a wide range of attributes under different situations, which results in the notion of paradoxical personality (Csikszentmihalyi, 1996). When such paradoxical tendencies are found together in one person, the term paradoxical is used to describe him or her. It is called as paradox because it seems self-contradictory, contrary to received opinion, and against our expectations. A paradoxical personality involves a wide array of personality styles in different contexts. Thereby, behavior fluctuates around a multiplicity of polarized attributes instead of settling into static traits.

It has been also hypothesized that the number of paradoxical traits, the complexity of personality, and the degree of creativity are related. The more paradoxical features are present in the same person, the more complex his or her personality will be, and therefore, his or her creativity will be more developed.

The creativity paradox or paradoxical creativity can be defined as the simultaneous coexistence in creativity of psychological elements that seem logically mutually contradictory. It is important to note that personality characteristics considered as important for creativity seem to be contradictory. For instance, critical and destructive attitudes may exist with constructive problem solving, self-criticism may be with self-confidence, fantasy may be with a strong sense of reality, and stereotypic masculinity and femininity (autonomy, self-confidence, and toughness vs. sensitive, intuitive and responsible) may exist together. According to the systems approach, distinction is not same as separation. When we distinguish between two things, we say there is a difference between them, but they are not necessarily separated or opposed. This is best exemplified by the distinction between yin and yang. Even though they are distinct, they are not separated. A systems approach stresses that such parts are interrelated and provide potentially generative interaction. The polarities in paradoxical personalities should be treated in this way. There is a cybernetic process in

creativity that goes beyond simple dualities. According to Barron, paradox is an aspect of humanness "... without stability, we can have no flexibility; without discipline, no freedom; without knowledge, no creation; without subjectivity, no objectivity" (1995, p. 35). Such dualities should be accepted as having a cybernetic relationship instead of opposites.

Paradoxes and Creative Personality

A creative personality can be described as a constellation and complex. No one trait leads directly to creativity. Instead, many of them, and their complicated interactions, bring about creativity (Runco, 2014). This is best observed in the paradoxical personalities mentioned earlier by several researchers. The research on paradoxical creativity is based mainly on case studies, currently showing scarce psychometric developments.

MacKinnon (1962) provided an interesting example of paradoxical personality in his study on architects. He found that creative architects are self-aware, open to emotions and express a wide range of interests. Even though the sample was composed of male architects and the data was collected when sex-role stereotypes were fairly polarized, they were found to be open to feminine options in their thoughts and behaviors. Based on such findings, MacKinnon concluded the importance of tolerating and integrating opposing values.

It is acceptable that the creative work itself provide the coexistence of conflicting traits. MacKinnon (1962, p. 490) stated, "it would appear that the creative person has the capacity to tolerate the tension that strong opposing values create in him, and in his creative striving he effects some reconciliation of them." Many creative people are aware of their conflicting traits or thoughts, and they utilize this because they know that it contributes to their creativity.

According to Barron and Harrington, people with paradoxical personalities are able to resolve antithesis or accommodate obviously contradictory traits in their self-concepts. Barron (1963) described a creative person as being, "more primitive and more cultivated, more destructive and more constructive, occasionally crazier and yet adamantly saner, than the average person" (p. 234). Similarly, Maslow (1976) asserted that creative people have the ability to manage conscious and unconscious and primary and secondary processes simultaneously. He also believes that the resolution of dichotomies allows creative people to integrate two opposite traits in a new synthesis. He listed pairs of traits, including altruism and hedonism, instinct and reason, duty and pleasure, and work and play. McMullan (1976) stated that creative individuals can jointly access two modes of thinking. He addressed the conflict between eight paradoxical characteristics: delay in closure versus systematic closure, divergent versus convergent thought, relaxation versus attention, discontented versus constructive attitudes, mindless perception versus understanding based on memory, emotional involvement versus detachment, disinterested motivation versus selfish motivation, and humble versus confident self-concept. Torrance and Hall (1980) also proposed that creative individuals can successfully reconcile polar opposites, including masculinity and femininity, independence and dependence, serious and playful, conformity and nonconformity, timid and bold, certain and uncertain, and receptive and self-acting.

Csikszentmihalyi (1996) conducted interviews with highly successful individuals from various domains and careers. He stated that if there has to be only one word that differentiates creative personalities from others, it would be complexity. What Csikszentmihalyi implies by complexity is that personalities contain contradictory extremes. Although such complexity is basically present in each person, most people are trained to develop only one pole of the extremes. For example, they are trained to cultivate humbleness and repress their proud side. Creative people, on the other hand, can have both poles either at the same time or at different times, depending on the situation. This does not imply neutrality, which means that a creative personality is never very competitive or very proud. Rather, it implies the ability to move between two extremes, depending on the context. Csikszentmihalyi listed ten pairs of paradoxical traits, integrated with each other in a dialectical tension, among many the qualities that individuals hold.

1. Creative people have a great deal of physical energy, but they are often quiet and at rest. They can concentrate and work for long hours with enthusiasm. This is possible thanks to a superior physical aptitude. They have high energy even in their seventies and eighties. This does not mean that creative people are hyperactive; rather, they can rest and sleep a lot. The crucial point is that their energy is under control and targeted. They, on the other hand, often suffered from illnesses in their childhood. Creative people's energy is also paradoxically manifested in sexuality. They may have a quite strong dose of libidinal energy; however, they may accept celibacy as a part of their makeup.
2. Creative people tend to be smart yet naive at the same time. Research has established well that a certain point of IQ, usually suggested around 120, is required for creative work as well as superior performance in real life. However, any increment beyond that point does not necessarily facilitate creativity. The reason why low intelligence impedes creativity is understandable. However, it may be puzzling that high intelligence interferes with creativity. People with a high IQ may excessively rely on their knowledge or mental superiority; thereby, they lose their curiosity to create something new. They may not have an incentive to question, doubt, and improve on existing knowledge. As Goethe stated, "naïveté is the most important trait of genius." The smart-naïve paradox can also be defined as wisdom-childishness. People who attain childish novelty tend to use well two opposite ways of thinking: the divergent and the convergent.
3. Creative people combine playfulness and discipline, or responsibility and irresponsibility. They typically have playful attitude and its antithesis, a quality of endurance and perseverance. For instance, working hard for long periods of time is necessary to overcome obstacles and, for example, to complete a novel. At the same time, they need to be playful while spending long times on their work without getting bored.

4. Creative people alternate between imagination and fantasy at one end and a rooted sense of reality at the other. These are needed to escape from the present without losing touch with the past. According to Einstein, the two forms of break away from reality are art and science, because these go beyond what we consider real and create a new reality. A creative artist may be as much a realist as a physicist, and a creative physicist as imaginative as an artist.
5. Creative people tend to be both extroverted and introverted. These are considered as the most stable personality traits that differentiate people. Creative individuals, on the other hand, may have both traits at the same time. They are able to alternate between inner-directed reflection and intense social interaction. A creative person needs to be alone in order to focus on writing, painting or researching, while it is also important to see others exchange ideas and know their work and minds.
6. Creative people are humble and proud at the same time. Famous people are expected to be arrogant. However, they may be self-deprecating, shy, and humble because they are aware of their own contributions relative to others in the domain where they work. They are aware of the role of luck in their achievements. They are also focused on future projects and current challenges rather than past accomplishments. On the other hand, they know that they have accomplished a lot in comparison with others. Thanks to this awareness, they have a sense of security and pride, often expressed as self-assurance. This contradiction can be expressed as a contrast between ambition and selflessness or competition and cooperation. These people often need to be ambitious and aggressive to create; nevertheless, they are willing to subordinate their own personal comfort and advancement to the success of the project being worked on.
7. Creative people, to an extent, escape rigid gender role stereotyping. In all cultures, men are expected to be masculine and repress attitudes and behaviors that the culture considers as feminine, whereas women are reared to do the opposite. However, it has been found that creative boys are more sensitive and less aggressive than other boys, and creative girls are more dominant and tough than other girls. Psychological androgyny is a concept that refers to the ability to be simultaneously aggressive and nurturing, sensitive and rigid, dominant and submissive, regardless of gender. Creative individuals, thereby, have richer opportunities and the strengths of both genders. It should be noted that despite having cross-gender traits, in general, creative women are perfectly feminine and creative men are perfectly masculine.
8. Creative people are both rebellious and iconoclastic, and at the same time traditional and conservative. Creative people are expected to be rebellious and independent. Yet they must first internalize a domain of culture to be creative. The fact that creative people need to believe in such a domain and know its rules makes them to a certain extent traditionalist. However, they should be willing to take risks and break with the safety of tradition to change and improve.
9. Most creative people are very passionate about their work, yet they can be extremely objective about it as well. These two extremes are crucial, because passion enables creative individuals to attain their interest in a difficult task. Besides, being objective about work provides credibility and quality.
10. Creative people's openness and sensitivity often expose them to suffering and pain, yet also to a great deal of enjoyment. It is obvious that high sensitivity can lead to suffering and anxieties not usually felt by others. For example, a creative poet can suffer when reading a bad poem and an inventive engineer get hurt because of a badly designed machine. In addition, eminence invites attacks and criticism, which causes pain. Having an interest in ambiguous subjects and thinking divergently is often perceived as deviant by the majority and causes creative individuals to be misunderstood and isolated. Yet, it is true that when creative people are working in their area of expertise, they get rid of all of their worries and experience a great deal of enjoyment. They savor the process of creation for its own sake.

The conflicting traits abovementioned by Csikszentmihalyi may be the most striking characteristics of creative people. It is noteworthy that all of them may not be observed in the same person. Creative people know both extremes and experience them with equal intensity and without inner conflict. They can move from one pole to another on each continua of personality traits in order to integrate polarities and express what we call creativity.

Acar and Runco (2015) examined the role of contradictions in creative thinking, providing supportive findings to paradoxical creativity. Their hypothesis was to question the theory of divergent thinking by asserting that the existing divergent thinking tests do not measure actual or literal divergence. So, they developed a method to measure literally divergent thinking, which, in fact, diverge. Acar and Runco identified 13 conceptual dichotomies based on creativity theories and research. Their contradictory categories are indicated in Table 1.

They examined the ideas generated by a group of examinees and found that some people exhibited contradictory thinking. This capacity was also found to be correlated with an external measure of originality.

Paradoxes in Cognitive Thinking

Rothenberg (1996) stated that the creative thinking process involves Janusian thinking defined as the simultaneous conceptualization of two or more opposite or contradictory ideas, concepts or images. The term derives from the qualities of the Roman god, Janus, who had two faces that looked in diametrically opposite directions simultaneously. Rothenberg identified four levels of the Janusian process: (1) motivation to create; (2) deviation or separation; (3) simultaneous opposition or antithesis; (4) construction of theory, discovery, or experiment. In the creative thinking process, opposing ideas emerge at the second and third levels. Then, Janusian thinkers consciously conceptualize opposite or antithetical ideas, concepts or propositions as simultaneous coexisting. Although these conceptualizations seem illogical and self-contradictory, they are constructed logically and rationally to produce

Table 1 Conceptual dichotomies suggested by Acar and Runco

No	Polar 1		Polar 2
1	Originality	vs.	Conventionality
2	Amoral, unethical, illegal, and malevolent		Moral, ethical, legal, and benevolent
3	Taboo responses		Nontaboo responses
4	Primary processes		Secondary processes
5	Experience		Nonexperience
6	Functional and practical		Impractical, aesthetics, and artistic
7	Synthetic		Nonsynthetic
8	Breadth		Depth
9	Feasible, realistic, and possible responses		Infeasible, hypothetical, and unrealistic responses
10	Natural		Unnatural
11	Humorous		Serious and sober
12	Sober, playful, childlike, and spontaneous		Mature and responsible
13	Close		Remote

creative ideas. These contradictions often resolve and disappear at the fourth stage. According to Rothenberg, Janusian thinking is essentially secondary process thinking; however, it modifies the primary thinking process by providing its “seeming ubiquity” and allowing “primary-process-like material” to appear in consciousness. The Janusian process has an important role in scientific creativity. Janusian thinking occurs as early conceptions in the development of scientific theories and artworks, as well as at critical junctures at later stages. It is usually not apparent in the final creative product because it serves generative functions in the creative process, and its simultaneous antithesis or opposites usually undergo transformation and modification.

Living With Paradoxes

Each individual originally has many contradictory qualities and experiences paradoxes more or less throughout their lives. However, they vary with respect to their ways of responding to paradoxes. Beginning from the early years of life, the way a person deals with paradoxes contributes to his or her development of personality. Most individuals prefer to behave in accordance with one or the other antinomy when faced with a paradox. For instance, boys or girls are expected to behave according to their traditional gender roles: masculine or feminine. They know what is expected and usually behave accordingly. This is a kind of conformity to social norms or pressures from the outer world. Some individuals, on the other hand, may follow their true feelings rather than conforming. So, they can be both masculine and feminine, according to the situation. These individuals are more self-expressive, among other positive psychological traits. It has also well established that psychologically androgynous people tend to perform high in creativity. Thus, children should be encouraged to follow and express their authentic feelings, rather than follow what is expected and conform to the demands of others.

According to Runco (2016), when people face a paradox, they may use different options to responding to it (Table 2). The first is they may recognize that there is a paradox, but they decide not to think further on it. They consider it as a dead end and do not invest any more time. The second is an unrealistic option because some people ignore or deny the paradox despite the fact that there is one. If there is a paradox, it is a paradox and should be acknowledged. Closing your eyes does not mean everywhere is in dark. The third option is also unrealistic because some people emphasize one side of the paradox over the other. The paradox, thereby, is diminished and the situation becomes one-sided. The last option is to integrate or conflate the two polarities of the paradox into a new interpretation. As such, there is no longer a paradox, rather, a creative interpretation of it. This can be illustrated by

Table 2 Four ways of responding to a paradox

Options	Response
First	Recognizing the paradox, but deciding not to think further on it. Consider the paradox as a dead end and not investing any more time.
Second	Ignoring or denying the paradox despite the fact that there is a paradox.
Third	Emphasizing one side of the paradox over the other. The paradox, thereby, is diminished and the situation becomes one-sided.
Fourth	Integrating or conflating the two polarities of the paradox into a new interpretation. So, there is no longer a paradox, rather, a creative interpretation of it.

dialectic thinking. When you have a thesis, then an antithesis, and eventually reach a synthesis, this synthesis is literally a blend of the thesis and antithesis in a new interpretation. There is no longer a thesis or antithesis, only the synthesis remains. Among the four responding options, the last is the most difficult and creative. Those using the last option accept the paradox as a paradox rather than ignoring it. They acknowledge that the two extremes of the paradox are there and true despite the fact that they seem opposite. Although this option is difficult, it can lead to creative thinking.

Contradictions or paradoxes are not problems; rather, they are opportunities. Teachers and parents who want their students or children to fulfill their creative potential should first encourage them to deal with paradoxes. Parents and teachers can provide paradoxical situations to children so they can be aware and then learn to tolerate them. Thus, children may practice dealing with dualities and integrate them into a new interpretation. According to Kohlberg, children's cognitive and moral development can flourish by struggling with dilemmas. His approach is directly applicable to the current discussion because he emphasized the benefits of experiencing dilemmas.

Children should be taught the creative use of paradoxes. They need to learn how to tolerate paradoxes rather than avoid or deny them. They should interpret paradoxes rather than ignore or eliminate them. Thus, they can take control over the paradox and have the opportunity to practice creative thinking. An interpretation or reinterpretation of a paradox is the basis for personal creativity. So, educators and parents should model and support the personal creativity of their students and children by encouraging the creative interpretation of paradoxes.

Summary

Human beings originally possess multiple paradoxical characteristics. While have been weakened or fixed, creative people usually retain both poles of paradox, which results in the notion of a paradoxical personality.

Janusian thinking is defined as the simultaneous conceptualization of two or more opposite or contradictory ideas, concepts or images and is involved in the creative thinking process. Janusian thinkers consciously conceptualize opposite or antithetical ideas, concepts or propositions as simultaneously coexisting.

The research on paradoxical creativity is based mainly on case studies, currently showing scarce psychometric developments. Several researchers have specified paradoxical personality characteristics. For example, Csikszentmihalyi noted ten pairs of paradoxical traits based on interviews with highly successful individuals from various domains and careers. Acar and Runco identified 13 conceptual dichotomies based on creativity theories and research. In general, creative people know both extremes of paradox and experience them with equal intensity and without inner conflict.

From the early years of life, the way a person deals with paradox contributes to his or her development of personality. Most individuals usually prefer to behave in accordance with only one pole when facing a paradox. Indeed, contradictions or paradoxes are not problems; rather, they are opportunities. Therefore, children should be encouraged to follow and express their authentic feelings rather than follow what is expected and conform to the demands of others. They need to learn how to tolerate paradoxes and learn the creative use of them. Thus, they can take control over paradox and have an opportunity to practice creative thinking.

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Participatory Creativity

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Gedankenexperiment: what would happen if Lev Vygotsky, Howard Gruber, Mihalyi Csikszentmihalyi, and Edwin Hutchins could work together with the task of coming up with a realistic and useful concept of creativity? In other words: what are the overlaps and synergies among sociocultural developmental theory (Moran and John-Steiner, 2003), holistic and constructivist lifespan development (Wallace and Gruber, 1989), sociocultural systems theory (Csikszentmihalyi, 1997) and research on distributed cognition (Hutchins, 1995)? Today, a number of emerging concepts of creativity combine these lines of research, including distributed creativity theory (Glăveanu, 2014a; Sawyer and DeZutter, 2009), some dynamic views of creativity (Beghetto and Corazzo, 2019) and recent elaborations on sociocultural views of creativity (Glăveanu et. al., 2019). Although all of these approaches describe the importance of social and/or material dynamics, certain theorists have focused on the different types of participation that bring about change in these systems.

Participatory creativity views thinking as largely constituted by social and material interactions over time – a distributed process – rather than solely or even primarily inside the heads of individuals. Although internal symbol manipulation certainly occurs as part of cognition and is important to creative work, the symbols come from the social and material worlds. Then the resulting ideas literally *take form* in the material world on computers and in notebooks, sketchbooks, lab journals, through conversations with colleagues, as well as in ultimate works. Much of the thinking of a painter is, thus, in the act of painting, of writers in writing and so on. Through this work over time, individuals develop distinctive points of view which they contribute back to their worlds in many roles. The painter, for example, draws from many people and sources in producing a work, and others – curators, gallery owners, collectors, reviewers, other painters, and so on – evaluate, interpret, reinterpret and respond over time. Indeed, the painter herself draws on multiple, internalized perspectives to produce the work. And all of the people in these roles are part of the creative process.

Theoretical Foundation

Drawing from the theories previously listed, participatory creativity builds on a number of foundational concepts.

- **Emergence in complex systems.** Creative ideas emerge through many people's work within complex, distributed social and material systems as described above. Even iconic "creative geniuses" drew from historical inspirations from books, paintings, and other artifacts, as well as from the contributions of teachers, colleagues, opponents, reviewers, and so on. People may be highly motivated to change social practices and material conditions, but they are never working outside of those conditions.
- **Creative work.** People who do creative work develop distinctive points of view over time through their participation in these systems as Gruber and his associates (Wallace and Gruber, 1989) argued. In other words, what develops through creative work is a point of view, as well as the ability to express that point of view effectively through a variety of possible roles. Indeed, it is common for people to participate in multiple roles. Writers are often also reviewers and editors. Scientists may edit journals and teach, and so on.
- **Integral roles of audiences.** In any of these roles people work within symbol systems that communicate ideas and, therefore inherently imply audiences. Those audiences may be institutional gatekeepers, such as editors and curators; formal audiences, such as collectors and consumers, or informal audiences, such as friends, and family. Audiences also include internalized representations of any of the above, a polyphony of learned perspectives, concerns, and values that people use to both inspire and evaluate the directions of their work.

- **Material actors.** Once thinking is liberated from the head, occurring within work not just in often fleeting internal symbol manipulations, the world itself becomes part of creative processes. Artifacts are actors. The artifacts do not themselves have intention but they are crucial in conveying, invoking, inspiring and influencing intention. A chance encounter with a work of art or literary passage can lead to whole new directions of creative work. Furthermore, the material world pushes back. Paint once on the canvass does not necessarily conform to the artist's vision or ecosystems to the vision of economic innovations. Such "problems" often guide the direction of work.

Taken together, these concepts shift some of the usual definitions in creativity research as well as the core questions that research addresses.

Definitions

- **Creative work.** Borrowing again from the developmental theory of Gruber et al., here creative work is the organization of resources to develop and express new and valuable points of view through a variety of possible roles.
- **Creativity.** The emergent course of change that results from these contributions determines what may be considered creative. In keeping with the long list of scholars who have argued that creativity is a value judgment (e.g., Amabile et al., 1996; Csikszentmihalyi, 1997; Glăveanu, 2014a), the creativity of any particular course of change – its value – must be an ongoing debate.
- **Creator as producer.** Note that in this approach people are not creative. They are not labeled as more or less creative or tested for their creativity. Traits like divergent thinking, along with the skills and knowledge people acquire, are resources that people can exploit and must manage to do creative work. What then happens to the individual creator? Were the works of the likes of Einstein, Picasso, Coltrane, Kahlo, and Gandhi not extraordinary? Such efforts remain extraordinary and important, but the individuals are not seen as solitary generators of the ideas for which they have come to be known. They are described as crucial *producers* who take leading roles in the exploration, construction, and advancement of particular points of view (including style, techniques and so on). In participatory creativity there is less pressure on these people to "be" extraordinary at every turn or to think "outside the box" of knowledge and experience than in more individualistic views of creativity. At the same time the participatory approach provides a realistic framework for understanding the goals, challenges, and possibilities of the producers' work.
- **Biographies of ideas.** History is also key for those doing creative work in any role and at whatever scale. Both everyday and earth-shaking ideas have "biographies" to which many people have contributed, not just those often credited with the idea. Understanding that can be important to the person who wants to influence the current course of history as creative producer or as part of the field evaluating works. It is also, of course, important for the student learning history. Then within any classroom project, the students' awareness of the biography of their ideas – the sources of inspiration, the wandering course of idea development, the number of contributors, and the roles they have taken on – can help position their ideas within the subjects they are studying, as well as promote collaboration and self-awareness. This awareness may also facilitate greater appreciation of peers and help the students define their goals for future participation within a realistic view of how creative change occurs.

Note: there is no claim that creativity is inherently or objectively good. The definition of creativity as producing a new idea or product that is of value still stands, but the relative nature of value is acknowledged. One person's art is another's sacrilege, one's exciting economic "disruption," another's economic ruin. The complex dynamics of creativity as a value judgment may be local, transitory and limited as in teachers and students recognizing new ideas in the classroom or viral videos on the Internet. The judgements can also be long-term and institutional as in recognized masterpieces in art and advances in science. In any case, though, "fields" can be nurturing as the agrarian metaphor suggests, as well as battlefields of value and change.

Even more inherent to the participatory approach than relative nature of value is the unpredictable nature of complex systems. By definition complex systems are not precisely predictable. Unexpected outcomes are not just possible but characteristic of the system dynamics, making the creative work of the "field" an ongoing process. Again, that work – idea evaluation, integration and application – involves both conflict and consensus among many people in a variety of roles.

New Questions

From individuals', organizations' and research perspectives, then, this view expands the questions about creativity. "How can I think of a new idea?" or "How do we help others think of new ideas?" are still relevant but no longer alone or even central. The more important questions become "What change do I want and how shall I participate – what roles shall I take up – in bringing change about?" Then: "How do I obtain and organize the knowledge, skills and gain access to the necessary social and material resources to be effective in those roles?" And: "How should each particular group or society set up its practices and institutions to help people make meaningful contributions?"

In addition, the crucial roles of idea evaluation, elaboration, and integration become important topics of research. How do the dynamics of different fields differ? How has technology changed roles? How can different combinations of roles serve the needs of different kinds of people and different historical conditions? And so on. There is also an overarching ethical controversy here.

Csikszentmihalyi (1997) stated the challenge, citing a quote from Jonas Salk about the goal of becoming “good ancestors” (p. 325) amid all of the complexity, unpredictability and debates, described above.

Goals

If there are other theories of distributed creativity, why define one that focuses specifically on issues of participation? Like other distributed and dynamic theories, participatory creativity aims to synthesize and advance current theoretical frameworks. Beyond overall systems analysis, the participatory lens then focuses specifically on how individuals experience, and contribute to, distributed creative processes. These are questions of development, education and roles within complex systems. This participatory focus is meant to enhance relevance to everyday and work life and to increase appreciation of creative contributions from different roles. The hope is that this appreciation will motivate greater participation by people who do not see themselves as visionaries or have been historically excluded from creativity narratives.

Advancing the Theoretical Framework

Each of the theories on which participatory creativity and related theories are built – developmental theories, sociocultural systems perspectives, and distributed cognition – overlap, each focusing on different aspects of creative agency and change, while including consideration of the core interests of the others. In the kind of distributed, historical process participatory creativity itself describes, these theories have contributed to different parts of a larger picture. The resulting, overall synthesis is hard to miss. The participatory questions concerning roles and patterns of participation for individuals can be overlooked, however. Indeed, focus on big-picture systems analysis can easily lead researchers *away* from individuals’ perspectives, challenges and development as participants in these systems.

Responding to the Needs of Everyday Life

Although the participatory view applies to creative work across history, today’s networked technologies have made the distributed nature of idea generation and evaluation part of everyday life. From online workplace collaborations to Wikipedia to viral memes to multiuser online games to social-network driven revolutions, the creative power of distributed systems is obvious. And the stakes are high. As noted above, the value judgment of creativity is a battlefield. Complex distributed systems currently build and promote exciting ideas to make life easier, healthier and more entertaining. Such systems also magnify bullying, produce “fake news,” and destabilize democratic institutions. Knowing how to think about, participate in, and manage these systems is emerging as one of the most important challenges of the 21st century.

Focusing on Practical Applications

As a conceptual framework participatory creativity applies to any of the contexts where creativity has been a concern. For example, Glăveanu (2014a) has studied how Romanian egg painters work within distributed systems. The technology startups that have grown rapidly in recent decades already understand complex distributed systems at the core of many of their products. Participatory creativity is then a translation of the products of this business sector to corporate organization and practices and to the development of the companies’ employees and founders.

To date, however, the main focus of participatory creativity theorists has been education. Hanchett Hanson has argued that teaching complex systems theories and practice is among the most important tasks for education in general and participatory creativity in particular. Traditional subjects can help students understand how new ideas emerge and are applied these dynamics. For example: historical research on the integration and unexpected consequences of new discoveries. In addition, study of biographies of traditionally recognized “geniuses” within the participatory framework can be a powerful means of deconstructing individualist mythologies and understanding the challenges and opportunities involved in creative work.

Clapp has worked with traditional classrooms and with design and makerspaces, emphasizing use of “biographies of ideas,” discussed earlier. In students’ projects both the values of multiple roles and the emergent nature of ideas can become evident when students and their teachers track the biography of their ideas. The same principle applies to studying history. At one school a teacher who traditionally taught a unit on Henry Ford as the man who brought the assembly line to mass production, now teaches the longer history of mass production in which Ford’s contribution is one component. The teacher sees advantages to acknowledging the contributions of many people over time, instead of focusing on the ideas of one man who had little in common with her students. In this approach she hopes to teach history more accurately and inspire students to see themselves as prospective participants in creative processes.

Clapp has also studied participatory profiles of students – a tracking of the frequency and amount of time different members of a student team spend in different roles (e.g., researcher, technician, spokesperson). This tool can help educators see the dynamic ways that students participate in creativity and can help students understand their own engagement in ways that honor their diverse talents, skills, background experiences, and perspectives. Clapp has emphasized, however, that the participatory profile should not be seen as a personality typology, closing off opportunities to take on new roles. In addition, there is not one set of defined roles that

fits every kind of creative work. On one project researcher and technician might be key roles, and another project might have roles for paint mixer and stylist.

Perhaps the most powerful educational impact participatory creativity can have is its emphasis on everyone's capacity to participate in creativity. Using the participatory approach, educators can proactively invite, honor and sustain diverse social and cultural perspectives, moving beyond emphasis on a select few – usually white men – that are used to illustrate creativity in many individual-based approaches.

Research Methods

Approaches to creativity that emphasize emergence in complex, distributed systems – including the participatory approach – have used a range of methodologies. There is still, however, much work to do. A crucial challenge to research is that the participatory approach is conceptually more comprehensive than any methodology will be. Therefore, it serves as a framework for designing and understanding research that will necessarily be more focused. At the same time, to be consistent with this framework research must avoid being reductive. In practice, this balance has generally been accomplished by studying several, but certainly not all possible, components of the systems in which people do creative work.

In-depth case studies of creative work have both inspired and facilitated development of participatory principles because this method is designed to study systemic interactions at a detailed level, rather than isolated variables. In applied settings, mixed methods have been used to capture multiple aspects of creative work dynamics. For example, in a study of a youth development program, Hanchett Hanson used a pre-/post-test design on social interaction tendencies with a test and comparison group. Those findings triangulated to observational rubrics and coded interviews to understand impacts of the social, material and temporal distribution of trauma narratives.

In general, participatory creativity studies have included observational rubrics, interviews, and a variety of different types of interaction analysis. An example is Clapp's use of the participatory profile and development of a biography of the students' ideas, previously discussed. In a different type of interaction analysis Glăveanu has used subjective evidence-based ethnography to study the interactions of a painter with his medium. The painter wore glasses equipped with a camera to capture his point of view while working then reviewed the video with the researcher.

Finally, the participatory approach provides a framework for re-evaluating other existing lines of research, such as trait theories, motivation research and historiometric research.

Conclusion

Participatory creativity is one of several related and recently emerging systems approaches to the concept and research of creativity. As the name suggests, participatory creativity reframes creative work as participation in a wide variety of possible roles within complex distributed social and material systems over time. This approach, thus, stands in opposition to the individualism that has characterized much of the history of creativity research as well as reductionist views of creativity as dependent on a single trait, trait profile, or formulaic process. Participatory creativity advocates a stance toward creativity that invites the widest breadth of perspectives into the creative process – including the perspectives of diverse groups of people who are often excluded from the popular creativity narrative.

For individuals, organizations and researchers, the participatory approach expands the core questions of creativity. Questions of ideation remain relevant, but now the more central questions concern what changes people desire in their worlds, in what roles they can help effect those changes, and how to develop meaningful points of view on those changes. That development includes acquisition of knowledge and skills and access to social and material systems. These questions also come with ethical considerations. For, amid the complexity and unpredictability, creative participation is inevitably participation in the ongoing debates about what changes are needed, what they mean and how they should be applied.

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Patents[☆]

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Intellectual property is an umbrella term that refers to any product of human creation. To protect intellectual property, a variety of methods have been developed, such as patents, trademarks, service marks, and copyrights. Artistic works, ideas, and the discovery of rules are not patentable. They are, however, protected under copyright laws. The present chapter focuses on patents, defined as *"the grant of property right to an inventor."* For the patentee, patents provide the right to exclude others using, making, selling, or importing their inventions. Patent systems have two main purposes: to encourage the development and disclosure of new creative works and inventions. First and foremost, patent systems aim to reward and encourage inventors for their research and creative work. Second, patents help to publicize scientific and technical ideas, which allows others to learn and reproduce an invention.

Although the issues of patents, trademarks, servicemarks, and copyright are hot topics in the modern economy, ideas and inventions have been the subject of intellectual property for a long time. While there is some historical evidence indicating that the initial version of patent rights first arose in Ancient Greece, Venice, an Italian state, is considered having the first patent system offering exclusive rights for inventions and new technologies in 1474. Gradually, many other European countries adopted similar patent systems from the Venetians. The goal was to improve economic development and protect intellectual property, but patent systems were also exploited for political and financial benefit.

In England in 1623, the Statute of Monopolies transferred the power to grant patent applications from the king to the parliament, which provided the foundation for modern patent laws. In colonial America, the first patent was granted by the Massachusetts General Court to Samuel Winslow for his invention of a new method of salt production. In 1790, the United States Patent Office was founded through the instruction addressed in the US Constitution that states *"Congress shall have the power ... to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."* In the same year, the first US patent was issued for Samuel Hopkins who invented a process of making potash, an ingredient used in fertilizer. Today, patents are the core of the global economy and competition with over three billion patent applications and hundreds of thousands of granted patents in each year around the world.

How the Patent Process Works

Different national and international patent institutions are recognized as having authority over patent-applied inventions and products. Many countries have their own governmental institutions, which take care of local patent applications. Since applying for patents in many countries is not always viable for inventors, some international organizations, such as the African Regional Intellectual Property Organization (ARIPO), the European Patent Office (EPO), and the World Intellectual Property Organization (WIPO) provide international patent rights for patentees. In the United States, the US Patent and Trademark Office (USPTO) is the main agency that processes patent applications for inventors and businesses.

The USPTO permits the granting of three types of patents: utility, design, and plant. Utility patents are for a new and useful process, machine, article of manufacture, or composition of matter, or any kind of innovation and improvement for listed categories. Inventors who develop a novel design for an article of manufacture can obtain patents for designs. Lastly, the invention, discovery, and asexual reproduction of a distinct and new kind of plant is patentable. Once an application is submitted, it is evaluated by examiners to see if the claimed invention is new, useful, and nonobvious, and whether the application complies with the

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legal requirements. The evaluation entails an intensive review of national and international patent documents, patent applications, and available literature regarding the claimed invention. When a patent is granted, it gives a legal monopoly to the patent holder for the following 20 years, starting from the date of application. Like any other property, it can be used for commercial purpose, as a gift, or left in a will.

US Patent and Trademark Office's Criteria for Creativity and Definition of Creativity

Defining creativity for both research and practical purposes is important because the definition influences the way we understand, measure, and research the phenomenon. Unfortunately, there is no consensus among researchers about the definition of creativity, but originality and usefulness are two terms that have been commonly used to define it. Runco and Jaeger noted that the original definition of creativity goes back to before 1900s, but they argued that Morris Stein should be credited for the standard definition of creativity as used in his paper in 1953. Since then, originality and usefulness have been used in creativity research as common defining terms.

Originality has been widely accepted as a defining characteristic of creativity, referring to novelty, uniqueness, and being uncommon. Novelty occurs in highly original things done by animals or found in nature and some ideas from people with mental illness, but such novelty does not make them creative. Therefore, it is not surprising that originality itself is not enough to define creativity. Creative products should also be intentional, and any novel products or ideas should be useful and serve a specific purpose.

For this second criterion, a variety of terms are used, such as usefulness, effectiveness, having value, appropriateness, or fit. For instance, The Systems Model of Creativity by Csikszentmihalyi (2014) suggests that a product be labeled as creative through a cyclic process. When an individual brings novelty into a domain, it is recognized and validated by experts and gatekeepers in the field. Gatekeepers make judgments not only about novelty, but also about the value of a product. Usefulness or appropriateness are more concerned with whether a product is feasible or effective for a given problem. For evaluation purposes, usually a dichotomous rating is used to determine if a given response is useful or appropriate for a specific problem. Considering the alternative uses (AU) divergent thinking test, the response "use as a saucepan" for alternative uses of "a cardboard box" may sound highly original, but it is neither useful nor appropriate, and thus would be considered a non or less creative response.

The US Patent and Trademark Office uses a similar but extended set of criteria in their examination of patent applications. Instead of two, they use three criteria: novelty, usefulness, and nonobviousness. For novelty, the USPTO requires that an invention not be "*patented, described in a printed publication, or in public use, on sale, or otherwise available to the public before the effective filing date of the claimed invention.*" Usefulness suggests that an invention has a practical utility. Lastly, regarding nonobviousness, a patent may not be accepted "*if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.*"

Thus, the first two criteria are commonly known in creativity literature, but the USPTO requires a new one, nonobviousness. As Dean Keith Simonton suggested, it could be considered or renamed as surprise. Surprise as a criterion of creativity is not new for the creativity literature; it was discussed by early researchers. Jerome Bruner, for example, addressed how creativity requires "effective surprise", and Margaret Boden used surprise as the third criterion of creativity along with novelty and being valuable.

Amy Landers (2010) elaborated on nonobviousness, "a person of ordinary skill," and the creativity-patent connection through an extensive review of the literature and court cases about patent applications. She pointed out that a person with ordinary skills is considered to be someone who has domain-specific knowledge and can apply it mechanistically. If a claimed invention can be re-created by a person of ordinary skill, it implies that the claimed invention is a predictable variation of the state of the art; thus, it doesn't fall into the category of nonobvious, and any patent application for such a claimed invention should be rejected. For instance, nails are widely used in the furniture industry, but using glue instead of a nail for a table or chair is a predictable variation of furniture manufacturing, and thus should not be rewarded with a patent. Interlocking wood sections that do not require nail or glue, on the other hand, could be considered for a patent application as a nonobvious improvement.

Based on the patent guidelines of the US Patent and Trademark Office, Simonton (2012) proposed a new definition of creativity that extends the current two-criteria approach by adding surprise as a third criterion. He used the formula, $C = N \times U \times S$, where N, U, and S stand for novelty, utility, and surprise, respectively, to show how the new definition might change current assessment practices. From this perspective, a product or idea is considered as creative when all three criteria are met, or mathematically when $C = 1$. The lack of any criterion leads to a non-creative result, such as when a product is novel and surprising but has no utility, it becomes non-creative ($C = 1 \times 0 \times 1 = 0$). Simonton pointed out that the new three-criterion definition with a multiplicative assessment approach has four implications for the assessment of creativity and creativity research.

The first implication is that the person of ordinary skill addressed in the definition of nonobviousness suggests that surprise is determined by a domain-specific expertise. When a claimed invention is seen as obvious by a person of ordinary skill, the invention will have zero surprise, and thus is considered non-creative. Although domain-specific knowledge might be necessary for creativity, it is highly questionable that surprising and creative products emerging from the combination of irrelevant or remotely associated ideas can be determined by expertise. Secondly, the three-criterion definition allows for a more flexible and culturally-sensitive assessment of creativity. While a dichotomous scoring, creative (1) or non-creative (0), is still a valid way to determine creativity,

with a three-criterion definition, scores can be weighted based on social context or the culture, and ideas or products can receive partial credit in assessment, such as 0.5 for novelty or 0.4 for surprise. Thirdly, surprise as a defining characteristic brings a new perspective to the subjective and objective conception of creativity. While the criteria for patents are explained and assessed objectively, the subjective assessment of surprise may widely change depending on an inventor's personal experience. Lastly, Simonton suggests that the three-criterion definition makes blind-variation and selective-retention (BVSR) a required process that separates creative ideas from non-creative ones through the generating and then testing procedure.

Although the three-criterion definition is not new for creativity researchers, further discussions on the operational definition and assessment of creativity based on the US Patent Office's criteria might open new possibilities and contribute to the understanding, practice, and research of the subject. Critiques of the three-criterion definition, on the other hand, may help to change and improve the current patent systems and evaluation processes.

Do Patents Foster Creativity?

Patent laws provide property rights as an incentive to inventors and researchers, and it is assumed that such incentives increase the quantity and quality of creative production. Patent laws may encourage inventors to invest their time, energy, and resources to pursue their work and creation. Otherwise, many inventors would not make an effort to create an invention in an environment where intellectual properties are easily copied and used freely by others. Patent laws are apparently effective motivators for inventors; however, it is controversial whether extrinsic motivation and rewards facilitate creative production. Teresa Amabile, for instance, proposed the componential theory of creativity, suggesting that creativity requires expertise, creative personality, and intrinsic motivation. In point of fact, extrinsic motivation and rewards have been frequently cited as the factors that reduce creativity. It is not surprising that doing something for personal interest, enjoyment, satisfaction, and fulfilment is associated with creative personality and production. Extrinsic motivators, however, are inevitable in many cases in which anticipated rewards and recognition are likely to contribute to the creativity of outstanding scientists and artists. For instance, James Watson, a well-known biologist and Nobel prize winner, had both an intrinsic and extrinsic motivation to win the Nobel prize as documented in his autobiography. As expected, personal recognition is the driving force for many creators. Thus, extrinsic motivation may not be as detrimental as previously considered if rewards and other extrinsic motivators are used as contributing factors rather than the main motivation of creative production.

Regarding the specific role of the patent system, there are two opposing views about the motivational function of patents on creators. One approach supports the idea that rewarding researchers and inventors with a patent might be counterproductive or even undermining for creative efforts. Theoretically, inventors are expected to have passion and an intrinsic motivation for their work; thus, they do not need an extrinsic motivator. An opposite view suggests that patent laws actually provide autonomy and foster intrinsic motivation, which in turn improves creative production. Of course, not all patents function as direct prizes for patentees. Unlike common rewards or grants in many domains, patents just provide exclusive rights, which may turn into greater benefits in the long run for inventors and businesses. Patents that lead to commercialized products may lead to greater returns for inventors; hence, there is an increasing number of patents and innovations in commercialized industries. It is also a reality that there are many patented inventions that are worthless based on the current economy of modern life, but many people continue to work on inventions that will not bring any economic benefit for the patentee [Nicholas \(2013\)](#).

Michele [Boldrin and David Levine \(2013\)](#) argued that there is a lack of evidence that patent systems improve innovation and productivity, unless productivity is not considered an equivalent to the number of granted patents. They pointed out that the number of patents has no correlation with productivity. The correlation between the patent system and innovation and productivity is controversial, and it is not surprising that the correlation differs based on the definition and measurement of innovation and productivity. Michele Boldrin and David Levine still have many valid points as to why patent systems may undermine creative production. For instance, while patents are effective incentives for inventors, they negatively impact the ability of every other researcher in the field to compete with the patent holder. Past patents also inhibit current efforts for further innovations, because the new innovators need to overcome many legal challenges and licensing requirements by patent holders.

A great case from history is the Wright brothers. Although there were several inventors in the aviation field, the Wright brothers have been credited as the inventors of the airplane because of their success in the first airplane flight and the patent for their flight control method. While their invention was a great success for the aviation industry, their airplane needed improvements to be a sustainable and reliable alternative for transportation. Instead of continuing their effort to develop a better airplane, the Wright brothers spent the rest of their career controlling the aviation industry and suing local and international aviators for infringements of their patent rights. Because of their excessive focus on patent protection, they were called "patent trolls" by Sean Trainor in *Time* magazine. Their contemporary and biggest competitor, Glenn Curtiss, however, spent most of his energy and effort creating a more viable airplane vehicle instead of being concerned about patenting his contributions, thus leading to many great inventions in the aviation industry. The Wright brothers, of course, filed many lawsuits against Glenn Curtiss and eventually required him to pay licensing fees for their patent. Their excessive control of the aviation industry stifled further innovation and progress in the aviation industry until the US government stepped in to solve the problem after World War I.

A similar story is the case of Thomas Edison. As [Adam Jaffe and Josh Lerner \(2011\)](#) mentioned in their book, *Innovation and Its Discontents*, Edison was granted the patent for lighting in 1880. During the following decade, a dispute arose about restrictions in the lighting industry due to Edison's patent rights. In 1891, Edison's company, Edison General Electric, filed lawsuits against its competitors. As with the Wright Brothers in the aviation industry, there was a dramatic slowdown in lighting industry regarding new

improvements and inventions. It continued until the patent expired. To be fair, it should be noted that Edison and his team conducted over a thousand experiments and spent a lot of money, time, energy, and resources to invent the first successful light bulbs and receive the patent rights. Thus, his desire to interpret the patent rights in an extended way and restrict other companies to use and improve his invention for commercial purpose is understandable. Nevertheless, the patent for lighting in this case undermined subsequent efforts to improve and develop more effective and sustainable lighting instead of encouraging inventors to work on lighting projects.

This blocking effect is more obvious in the current global economy in which the production of many goods consists of many smaller components, all of which are subject to patent laws. For instance, a mobile phone has a screen, battery, charging technology, technical solutions, camera, operating system, and transmitter, such that a new inventor or company has to deal with the patent holders and the long-licensing procedure to be able to produce and sell their products. Many big companies, like Apple and Samsung, spend billions on patent wars, which leads to a reduction in their budget for research and development. Since Steve Jobs introduced the iPhone and Mac computer, there has not been an extraordinary invention in the computer and phone industry beyond making products lighter and thinner.

It is also not surprising that many great historical inventions, even in 19th and 20th centuries, emerged outside the patent system. Thus, the patent system may not be the underlying mechanism contributing to creativity and innovation. As Michele Boldrin and David Levine suggested, inventors may receive similar benefits from their inventions through different mechanisms, such as first mover advantages. Summing up, despite the addressed benefits for patent holders and providing incentives for researchers and inventors, the current patent system seems to be detrimental to creative production.

Multiple Discovery and Patents

Multiple discoveries, also called simultaneities, occur when researchers work on the same project or invention in a parallel but independent way in the same time period, and the same or highly similar invention is created by two different inventors. One of the most famous examples of multiple discovery is calculus. In 18th century, both Isaac Newton and Gottfried Leibniz discovered calculus simultaneously. Although Leibniz was the first to publish an official paper about the topic in 1684, Newton made some references about calculus in his personal notebook as early as 1666. In the aviation industry, Jean-Francois Pilatre de Rozier succeeded the first balloon flight in 1783. Although the Wright brothers are known as the fathers of the airplane, a couple of other inventors, such as George Cayley from England, Gustave Whitehead from Germany, and Richard Pearse from New Zealand achieved their own flights all before the Wright brothers. The Wright brothers received the credit because of their invention of the controlling mechanism, the first “successful” flight, and being granted a patent for their invention. Furthermore, identical theories of natural selection were developed by Charles Darwin and Arthur Russel Wallace independently.

Multiple discovery is not limited to these famous inventions and discoveries; indeed, it is a common pattern seen in science history. In an early study, William Ogburn and Dorothy Thomas cited 148 multiple discoveries in 1922. Dean Keith Simonton used 579 multiple discoveries for the analysis in his seminal study about multiple discovery and invention, and it is possible to add many more since then. Ogburn and Thomas believed that innovations become inevitable considering that accumulated knowledge and social development encourage inventors to invest their attention and resources in a particular problem. Their approach seems to contradict the “great man” or “genius” theory that attributes discoveries and progress to exceptionally talented individuals (See Discovery and Multiple Discovery).

It is not surprising that required knowledge and ideas had been available for a long time for some inventions before they were finally brought into being. For instance, even though flying cars have been a dream for a long time by many people, and the technology in the aviation and car industries has been available to combine two different transportation technologies, a patent application for a commercial flying car was just filed in 2018. Thus, with accumulated knowledge and social demand, people with exceptional creative and intellectual abilities still play an important role in inventions.

The *zeitgeist* is also a useful phenomenon to understand multiple discoveries. As defined by Edwin G. Boring in his seminal paper in 1971, the *zeitgeist*, a German term meaning the “spirit of the times,” refers to “the climate of opinion as it affects thinking” and “the total body of knowledge and opinion available at any time to a person living within a given culture.” The *zeitgeist* favors certain domains or inventions at certain time periods. In the Renaissance, for example, art, literature, and philosophy were highly appreciated, which may explain why some of the greatest scientist, inventors, artists, or authors emerged during this period. Leonardo da Vinci, Michelangelo, and Sandro Botticelli are just some of the Renaissance artists who have had a lasting influence on modern art (See *Zeitgeist*).

Besides the concepts of genius and the *zeitgeist*, Simonton (1979) also examined chance as a theory of multiple discovery. He conducted four critical tests to determine which theory is most plausible to explain the multiple discovery phenomenon. The results indicated that chance theory was the best explanation. Although chance theory was the most significant one, Simonton pointed out that genius and *zeitgeist* theories are still valid approaches to understand multiples.

While Simonton’s study included an extended list of multiple discoveries, national or international patent offices are in a better position having a potentially vast amount of data and information about multiple discoveries. These patent offices have the authority to grant patents in cases of multiple applications filed by independent inventors for the same or similar inventions. In the last decade, more than half of the patent applications have been denied each year, and it was also the case in the earlier decades.

Although a lack of usefulness and nonobviousness might be the reasons, a lack of novelty is possibly the most common cause for rejection. Adam Jaffe and Josh Lerner (2011) addressed how the US Patent Office's handling of the issue of novelty for multiple discoveries may undermine the development of subsequent improvements. It is common for different companies or individuals to apply for a patent for the same or a very similar idea or set of ideas. It might be fair that they all receive credit for the unique aspect of their creation, but in reality, it is not the case most of the time. Patentees usually use a considerably ambiguous language for the description of their inventions, which may lead to different interpretations about whether the current patent covers similar improvements or inventions by other applicants. It makes the patent system a subject for courts and some judges favor a narrower interpretation of patent coverage, while others favor a broader coverage of patent rights and the interpretation of a description of an invention. As a result, many companies or inventors hesitate to commercialize their ideas due to the possibility that they might encounter the extensive cost of a lengthy litigation process.

Patent systems are expected to improve innovation, however, patent systems in such cases may undermine rather than improve innovation. A great example from history is the invention of the radio by Guglielmo Marconi (Of course, who invented the radio or many other inventions is still a controversy for some.) Besides the radio, he was granted a patent on the two-element vacuum tube, called a diode, which was used in radios and TVs. Lee De Forest, an American inventor, improved the diode and invented the triode. Although the triode was a distinct and improved model of the diode, the case became the subject of litigation. The court ruled that the triode was an improved version of the diode, and Lee De Forest and AT&T, the owner of the triode patent, needed to receive a license from Marconi to be able to use it. Marconi refused to offer a license, and the use of the triode, a major improvement in technology, was delayed due to the dispute. Because of similar problems, Kent Walker, Google's Senior Vice President for Global Affairs and Chief Legal Officer, once said in an interview that "A patent isn't innovation. It's the right to block someone else from innovating."

Patents in Assessment of Creativity

The assessment of creativity is a fundamental issue in creativity research. Since Guilford's seminal speech at the 1950 APA Annual Convention, a variety of measurements of creativity has been developed. Available assessment methods in the creativity literature aim to measure various aspects of creativity, including but not limited to, divergent thinking, creative personality, creative achievement or activities, personal attitudes, and product evaluation. One distinction among creativity tests is the use of subjective vs. objective assessments. A subjective assessment usually relies on self-report data, personal observation, and the perception of supervisors, teachers, parents, or raters, which might be biased. An objective assessment, on the other hand, requires expert judges, trained raters, or computer programs for scoring creativity tests.

Although divergent thinking tests rely on individual performance on given divergent thinking tasks, many creativity studies base their findings on self-reported data about different aspects of creativity, such as ideational behavior, creative achievement, personal attitudes toward creativity, and the perception of support for creativity in school or work settings. In many cases, the validity of self-reported data is questionable unless the findings are triangulated with other measures and evidences included in the study.

For instance, there is a growing body of research about the perception of teachers on creativity and creative students. The results, in general, imply that teachers value creative children and creativity as an essential skill for the 21st century. When it comes to classroom practices, however, many teachers find it highly challenging to deal with creative students or integrate creativity in their regular curriculum. Thus, teaching practices might not be in line with teachers' self-reported beliefs and values about creative students. As an alternative, researchers use observations, self-report data from teachers, students, and parents in schools, or employees, co-workers, as well as supervisors in organizational settings to triangulate the data sources, whereas these supporting data sources are still not free from bias and could be influenced by demographic characteristics, social desirability, personal relations, and the halo effect (See Education).

Patents and patent applications are considered relatively more objective ways to assess creativity and are used as criteria for creativity and innovation in some studies. The number of patents or patent disclosures written by individuals has been used to assess personal and group creativity. From a broader perspective, these patents are used to compare regions, states, or even countries regarding how creativity and social and political structure are connected, as well as how productivity and innovation differ around the world. As stated, patent applications are reviewed by expert examiners, and for nonobviousness, "a person of ordinary skill" plays a key role in determining whether a patent application is a predictable variation of an available product or invention. Both examiners and "a person with ordinary skill" rely on their expertise to judge whether a patent application meets the required criteria. Using one's expertise for the assessment of creativity is not something new in the creativity literature. Teresa Amabile, for example, developed the Consensual Assessment Technique (CAT) in which participants are asked to create a creative product, which are evaluated by a group of experts in that field. A number of studies using the CAT has revealed considerable evidence of inter-rater reliability (See Consensual Assessment) Patent evaluation is, of course, not identical to the CAT, but it still relies on personal expertise. With a limitation of expertise on assessment of surprise or, in general, creativity as a complex phenomenon, patent applications or the number of patents could be considered as an alternative and more objective way of assessing creativity, especially in the research and development industries that require a high level of innovation.

Patents in Creativity Research

As mentioned above, patents have been used in creativity research literature as an indicator of creativity. For instance, Huber (1998a, 1998b, 2000) examined big C creativity among inventors and used the number of patents, as a form of nationally recognized achievement, to measure creativity of the inventors. His studies indicated that inventorship is a form of creativity, patented inventions are rare, and the time pattern of inventions is random. McCann (2011) also used the number of patents per state to examine the relation between creativity, conservatism, and openness to creativity. Based on the results, the number of patents per state population was lower in conservative states and higher in more open states. McCann's study was extended and replicated by Runco et al. (2017). The number of patent was again the criterion measure, but instead of state level, it was used for counties. The results supported the negative correlation between conservatism and creativity.

From a different perspective, Huang et al. (2012) examined global collaborative creativity based on the number of patents emerged through international collaboration. Their study indicated that there is a growing number collaborative work among international researchers, and more and more patents are granted through collaborative creativity. Instead of number of granted patents, patent applications or disclosures were also used to measure employee creativity in organizational settings (Oldham and Cummings, 1996). Clearly, use of patents in creativity research is not limited to the cited studies, and patents, patent applications, and the creativity framework suggested by US Patent Office continue to offer useful research tools and questions for creativity researchers.

Conclusion

Patents entail legal documentation to protect the products of intellectual property and provide exclusive rights for patent holders for a specific time frame. It has a long history and currently there is an increasing interest and global competition in patent applications and protecting intellectual property rights. The patent systems are highly influential to creativity, especially in domains with high number of commercial products, and have implications for research, development, and the understanding of creativity. For patentees, patents provide exclusive rights and benefits, and they function as an effective incentive for investor's commitment in time, money, and resources. For many firms or individual researchers, however, the patent system is a burden that discourages new firms and researchers from improving and commercializing patented inventions due to the fear of legal challenges and licensing requests by patent holders. Another critical issue concerns multiple discoveries and the tendency for patent systems to favor the initial and more salient applications, which leads to undesirable results for the other applicants, even if they had the same idea or invented the same or a very similar invention during the same time frame or even before. It is highly questionable whether the idea of a patent or patent system still serve the purpose in encouraging the development of new creative work. Further studies and discussions are needed to improve the current patent system and establish well-defined boundaries for patent monopolies.

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Personal Creativity[☆]

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Glossary

Discretion Knowing when to be creative and when to be conventional instead.

Intentions Usually a reflection of a value system and may lead to mindful efforts and are thus often apparent in what the person is motivated to do.

Interpretation The result of cognitive processes, and in particular those involved in the construction of meaning.

Personal creativity Original and effective thinking and behavior that may have no social expression and may not lead to manifest product.

Self actualization The highest form of psychological health that allows true spontaneity and the expression of authenticity.

Introduction

Scientific theories are not static. They develop and change. Some tenets are added, some are refuted and taken away. Hopefully there is progress, which means that a better understanding of ourselves and our world is constructed. What is unique to the sciences is that the methods, standards, and goals are maximally objective.

Creativity studies have adopted objective methods, standards, and goals and have thus become quite scientific. Yet creativity studies are in some ways unique. Creativity is different from all other human behaviors and potentials, and this means that there are unique difficulties for scientific research on the topic. Few other research topics are as unpredictable as creativity. Indeed, creativity is by definition unpredictable because originality is required. If something is original, it is unlike everything that came before it and is in that light unpredictable.

An enormous stride toward scientific respectability was made when J. P. Guilford, President elect of the American Psychological Association, argued so convincingly for empirical studies of creativity. He described creativity as a natural resource and pointed to the pressing need to invest in both its study and its encouragement. He also described various methods for the study of creativity, or at least for the study of creative potential. His distinction between divergent and convergent thinking has proven to be quite useful and, although it has been around for decades, is still cited with regularity. Another large step was taken at the *Institute for Personality Research and Assessment* (IPAR), not long after Guilford's Presidential address in 1950. Objective information about architects, writers, and various other professional groups was collected at IPAR, mostly with reliable personality inventories and tests of cognitive skill and style. In this manner a great deal was learned about domain differences, and all kinds of objective information about those creative professions was reported in the psychological literature.

Personal Creativity and Optimal Objectivity

The theory of personal creativity is much newer than the work at IPAR and other seminal efforts. It differs from them because it views the highly objective work to be exaggerated. It suggests that we can be too objective about creativity, and if we are, we lose the most important part of creativity, which is in fact personal and is therefore not entirely amenable to objective study. This may sound like an extreme claim about what is most important but it is based on the fact that personal creativity is required for

[☆]*Change History:* August 2019. Mark Runco updated affiliation and clarification was added to distinguish personal creativity from social creativity. The discussion of personal creativity as related to but distinct from self-actualization was extended. This article is an update of M.A. Runco, Personal Creativity, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 220–223.

everyday and ordinary creative problem solving—and required for world class creative achievement. World class creative achievement certainly requires more than personal creativity, including persistence, determination, large and diverse knowledge bases, and social impact, but it starts with the same personal processes that characterize everyday and ordinary creativity. Personal creativity is, in that sense, a prerequisite to all creative behavior. This article briefly describes the theory of personal creativity. Since it was developed largely as a response to social and product views of creativity, it begins with a summary of them, and thus puts personal creativity into context.

Product Views of Creativity

Products represent one of the primary strands in creativity studies. The other strands, according to the 4P framework, include process, person, and press (or place). There really are several product strands. One focuses on tangible results of creative work. There is, for example, a detailed 'matrix' for assessing products which can be used with all kinds of things, from chairs to new tools for writing. Robert Weber has also presented detailed analyses of individual products, though his interest seems to be more in invention than in isolating the characteristics of creative products. Inventions certainly represent a good example of creative products. A list of creative products would also include works of art (e.g., paintings), compositions, publications, presentations, performances, copyrights, patents, motion pictures, films, videos, computer software, 'apps' for cellphones, designs, and video games.

Many of these imply that product research involves only the work of adults, but checklists of productivity have also been used successfully with adolescents. These tend to be used as criteria in studies of predictive validity or in longitudinal research. Almost always the score provided by such checklists reflects the quantity of creative work (the number of products, and perhaps the number of awards as well) rather than their quality. Other times single products, such as chairs or inventions, are entirely disregarded and the issue is on *productivity*. Here the products themselves are not important at all; the only concern is with the count of or quantity of things produced. Research using productivity may not even identify the products; it may just analyze some number that represents how many things each creator produced. Not surprisingly, this kind of research is often archival. It may involve an analysis of age, for example, and thus look to encyclopedias or other records to see how many things tend to be produced when the creator is in his or her twenties, in comparison to how many are produced when the creator is in his or her thirties, forties, fifties, and so on. This kind of developmental comparison is interesting and shows that different domains of creativity seem to have different peak ages. There are questions with this line of work because the focus is on counts and productivity and not creativity *per se*.

Social theories of creativity take quality into account by examining judgments or attributions of creativity, originality, aesthetic appeal, and effectiveness. Some of this work is historical, in which case the issues mentioned above are still apparent. But sometimes judgments of products are obtained in experimental research and used as data. Judges in the consensual assessment method, for example, are explicitly asked to rate poems, collages, or the like for creativity, in which case there is a reliance on the product but the concerns with historical research (e.g., "cohort differences" and the like) are avoided. Obviously none of the product research, historical or otherwise, says much of anything about the processes used by the creators. This is an overarching drawback of all product research.

Systems theories of creativity, which are quite popular, assume that attributions by judges are required of all creative work. In the best known systems theory of creativity, an individual produces an original idea, and if its value is recognized (which assumes that the domain and culture value work in that domain), the idea may become known by others working in the field. If it is truly a good idea, it may change the way people (both laypersons and experts) think, and thus become part of the universal knowledge base. Individuals entering the domain at that point will be exposed to that idea as a part of the existing dogma, in which case the idea has gone the full cycle, from a person, to the field, to the domain, and then to other individuals. In the extreme view of this kind of systems theory, a creative idea is only creative when it survives the entire system and has interpersonal impact.

There are several problems with product, social, and systems views of creativity. Some are circumvented by the theory of personal creativity. Indeed, the theory of personal creativity was developed in direct response to what was seen as an exaggerated and unrealistic use of products and social attributions and judgments in theories of and research on creativity. Put differently, the theory of personal creativity was proposed to insure that the scientific study of creativity does not go too far in the direction of objectivity. Social and product theories of creativity are highly objective – products can be counted, inter-rater reliability easily determined – but too often they exclude much of what is most important about creativity.

The most notable problem with product and attributional theories of creativity may be that they focus on the results of creative work – the products or performances that result from creative efforts or the reactions by some audience to the creative person or the products. They dismiss the process used to be creative. This is unfortunate because if we really want to understand creativity in a way that will allow its encouragement, the process and underlying mechanisms must be precisely identified. Product and social theories do not allow that. They focus on reactions rather than on creation.

A second problem involves historical shifts and revisions. The basic idea here is that attributions of creativity change. They vary from era to era. This kind of variability indicates that social judgments are unreliable. That is exactly the way to describe the issue because reliability is defined in terms of consistency and stability. How can we rely on social judgments if a person is deemed creative at one point in time but not creative later? Examples of this are easy to find (e.g., Rembrandt). Clearly social judgment is

indicative of more than creative talent. It reflects many factors that are extraneous to creative talent (including luck!) and are really just indicative of fame, reputation, and impact.

Defining Personal Creativity

The theory of personal creativity focuses on the individual. No impact or reputation is required, which separates personal creativity from social and systems perspectives. Personal creativity is, on the other hand, congruent with the humanistic view. As exemplified by Carl Rogers and Abraham Maslow, humanistic views of creativity emphasize self-expression and self-actualization and de-emphasize products, attributions, and the like. Both Rogers and Maslow eventually concluded that creativity and self-actualization are inextricable from one another. That suggests a divergence of the theory of personal creativity and the humanistic approach. The latter is tied to a definition of psychological health that is not a part of the former—at least so far.

Probably more important is that the theory of personal creativity makes precise predictions about the mechanisms that are required for all creative achievements. As implied above, this mechanism is involved not only in children's creativity and the everyday creative problem solving of noneminent persons as they strive to solve large-scale problems or produce world-shaking work that is used by eminent creators as they strive to solve large-scale problems or produce world-shaking work.

Personal creativity involves (a) the construction of original interpretations of experience, (b) the intention to construct and use those interpretations, and (c) the discretion to recognize when to rely on original interpretations and when to rely on rote and conventional thoughts and actions instead. On a behavioral level it is discretion that is necessary for the individual to know when to be creative and when to act in a conventional fashion instead.

The first of these – the construction of interpretations – can be understood by considering how *sensation* differs from *perception*, on a cognitive level. Sensation is entirely dependent on the five sensory systems. Each of these (sight, smell, taste, touch, or hearing) brings experiential data into the cognitive system. The sensory systems do not alter data in any way; they merely detect information and bring it in, where it can then be processed. The information brought into the cognitive system via one of the sensory systems is therefore raw data. At that point the cognitive system can attempt to make sense of it. This is where perception begins. At that point information is analyzed, translated, transformed, considered, compared, and so on. All of this allows the individual to construct an understanding of his or her experience. The key point is that sensation differs dramatically from perception in that the first uses only raw data and the second transforms that into meaningful information. The transformation may occur in various ways, but they key is that it allows the construction of interpretations. Indeed, an *interpretation* is synonymous with the construction of meaning. That is the process that supports personal creativity. If the construction of meaning – the interpretation – is original and effective, it is creative. It is creative only on a personal level, but it might later be made social or elaborated into some sort of product. At first, it is unshared personal creativity.

The process used to construct interpretations was viewed as *assimilation* by the developmental cognitive psychologist Jean Piaget. Assimilation is not the same as adaptation, which, for Piaget, also involved accommodation and changes in cognitive structures. In fact, creativity is distinct from adaptation in a number of ways. Creativity can be proactive, for example, while adaptation is by definition reactive. Creativity can even be maladaptive, as is suggested by the dark side of creativity and the destructive tendencies of some creative individuals. Assimilation is only one part of adaptation. It is defined as a cognitive manipulation and alteration of information. It is what is known as a top-down process in the cognitive sciences and is manifested whenever a personal interpretation is constructed. Interpretations are constructed; they are not merely bottom-up representations of the external world. Individuals actively construct interpretations. They do not merely find them in the environment nor simply remember them.

None of this implies that all thinking is creative. As people age they develop assumptions, routines, and habits, and much of their behavior depends solely on them. These are not original. Occasionally we do mindfully construct an original interpretation that is also effective. That is a creative act. We may then elaborate on it, refine it, apply it, and perhaps even share it, and it might eventually make itself known in the form of a product or performance, in which case it is possible that it is socially recognized as creative. But at first it is just a new interpretation. It is a personally creative act.

There is research on individual differences in the use of creative interpretations. Gudmund Smith, for example, developed a technique to assess interpretative tendencies, or what he calls *percept-genesis*. This technique involves presenting ambiguous figures to individuals and asks them for possible interpretations. Since the stimuli are ambiguous, varied interpretations are possible. Results from several studies confirm that creative persons are able to construct meaning with less information, when the stimuli are more ambiguous. There are age differences, with less creative performances at age 7 and 12. Another drop often occurs in middle age. Smith and colleagues have reported good reliability and several kinds of validity for this method in the *Creativity Research Journal*.

There is also relevant empirical research on self-actualization, but keep in mind that personal creativity is not identical with self-actualization. Personal creativity is not dependent on the fulfillment of lower level 'needs' as is assumed by humanistic theories, and personal creativity is not necessarily tied to psychological health, as is the case for self-actualization. That being said, there are instances where the distinction between personal creativity and ill-health are quite clear. The originality that is expressed by psychotic individuals is not creative, for instance, in part because it is not an attempt to understand the world and not intentionally constructed, as is required by personal creativity. As stated above, the original interpretations of experience that contribute to personal creativity are intentional.

Contrarianism, blind nonconformity, and other forms of unconventional behavior are also distinct from creativity. They might lead to originality but they are not at all good indicators of creative talent. Truly creative individuals tend to the unconventional, but the vast majority of them also fit well into society. They are able to do so, even though they have original insights, because they exercise their *discretion*. They know when to be original and when to fit in. They are not blindly original, out of control in their originality. Frank Barron described creativity very nicely, in 1995, as ‘controlled weirdness.’ All of this reinforces the idea that creativity is not equivalent to originality, and that sometimes original individuals are not creative. This is why the theory of personal creativity states that the individual constructs original and effective interpretations, and why it also recognizes intentions and discretion.

Enhancement

The fact that discretion is a part of personal creativity suggests a method for enhancement. That is because techniques have been developed to encourage and exercise discretion. These techniques have been used with the hopes of facilitating the development of moral reasoning skills, but since they focus on discretion, there is every reason to believe that they could be adapted to creative thinking as well. If they are effective, individuals should recognize that it is good to be original, but only some of the time. This would parallel the recognition that it is good to fit in, some of the time, or to use the terminology from the research on moral reasoning, it is good to be conventional, some of the time. It is also good to be *postconventional*, which is the most mature level of moral reasoning. Postconventional individuals understand rules and conventions, and to take them into account when making decisions, but they think for themselves. This allows mindful action rather than either blind conformity or blind originality. It also allows originality to work with discretion.

Another approach to enhancement emphasizes (a) providing opportunities for self-expression and originality as well as (b) appropriately rewarding and (c) modeling those same two things, self expression and originality. Modeling is especially relevant to personal creativity because it has a twofold impact: it provides actual examples of creative behavior, which can be imitated, and it demonstrates that creativity is a valuable thing. It thus communicates appropriate values. These values are critical for intentionality and the enhancement of creativity. If individuals do not value creativity, they will not put any effort into being creative, nor try to develop creative skills. They will not invest in their own creativity. They simply will not appreciate it and thus will not care about it. But if individuals see the value of creativity, they will try to be creative and try to become more creative. They will appreciate it in others as well. The value of creativity can be communicated via creative models, including parents, teachers, and supervisors.

Conclusions

The most important part of personal creativity is that it is universal. It is not just a part of the creative efforts of ordinary people and everyday actions, but also plays a role in eminent creativity. It does not just describe what an individual does, but it also describes the efforts that precede and are required for socially recognized creativity. Recall here that personal creativity precedes attributions of creativity and the completion of creative products. All creativity begins with the construction of original and meaningful interpretations. These may go no further. They remain personal. Or they may be elaborated, tweaked, shared, and have an impact, in which case they lead to social creativity.

A second important part of the theory of personal creativity is that it attempts to get at the actual mechanism that is involved in all creative work. This mechanism is hypothesized as interpretive and assimilatory. Given that everyone can assimilate, this underscores the universal nature of personal creativity. Admittedly, many people put less and less effort into originality as they age, but that simply means that some people rely more and more on habit and routine as they age and exercise their creative self-expression less and less. With that in mind the practical implications outlined above are especially noteworthy. They offer techniques that may counter the tendency toward habit and routine and encourage discretion and the intention to be creative and to develop creative skills.

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Personality: Big Five Personality Characteristics

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Introduction and Construct Conceptions

Psychologists and other researchers have examined the relationship between creativity and personality for well over half a century. During that period, conceptions of personality have evolved greatly as have those of creativity. Discussing the relationships between factors and facets of personality and elements of creativity requires a bit of initial clarification and groundwork.

Understanding the context and evolution of thinking on both sides of the personality-creativity connection provides a grounding to appreciate current research and conceptions surrounding the relationship. In this entry, personality will be considered using the most common, research-based framework of the day: The Big Five model. Over the past twenty years this has evolved to be the most commonly employed framework for assessment in studies of creativity and personality. Research-based conceptions of creativity have remained more varied and nuanced during that time, but commonalities can be extracted for clarity. The definition of creativity used here will be centered on novelty and usefulness, but the consideration of context will not be discounted. In addition to relating factors and facets of the Big Five personality framework to creativity, other relevant issues such as domain-specificity, issues of creativity measurement, and emerging future directions will be discussed.

Early Research

J.P. Guilford's 1950 address to the American Psychological Association set researchers on a path to more systematically clarify and describe the relationship between creativity and personality traits. In his speech, Guilford's stated aim was promoting the development of what he called "creative personalities." His premise was that if the underlying, intrinsic characteristics of highly creative individuals could be identified, these could be cultivated more broadly across settings such as schools to increase the general pool of creative talent. One should pause here briefly to appreciate the potential conflict of believing in a largely fixed personality while simultaneously aiming to develop such traits. However, to the extent that the development of creative talent begins with identifying it for advancement, there was definite value in Guilford's aims.

Creativity research in these early years focused on the study of creative eminence and the personal and personality characters of those eminent creators. This line of research involves working backward from lists and/or profiles of creatively eminent individuals and identifying common threads. Often this was done within a given domain, but sometimes the work was carried out across domains to find more generally applicable findings.

Frank Barron and Donald MacKinnon exemplified this sort of work with their examinations of highly creative individuals who were examined at the Institute of Personality Assessment and Research. Personality inventories and assessment were typically at the heart of studies of individuals as diverse as scientists, artists, architects, and writers (see Barron & Harrington, 1981). This work paralleled earlier efforts by Louis Terman and Leta Stetter Hollingworth to profile those deemed intellectually gifted based on intelligence tests in search of a defined gifted personality. In contrast to this work, MacKinnon and Barron viewed creativity as something to be developed, even in the absence of high general intellectual ability. (See Intelligence)

The first personality inventory commonly used in creativity studies was the Adjective Check List developed by Harrison Gough and Alfred Heilbrun (see Gough & Heilbrun, 1965). This instrument includes 300 adjectives. Through the completion of the

Adjective Checklist List, 37 resulting scales were developed. Among others, these varied scales included measures of basic psychological needs, method effects, and those factors associated with other relevant psychological constructs and potentials.

One of these latter “topical” scales related to the creativity personality. Gough went on to develop this into the Creative Personality Scale, an abridged scale limited to the 30 items most commonly associated with creative achievements across multiple domains (see Gough, 1979). On the scale, subjects are asked to indicate whether each given adjective describes them. Some responses are scored positively for creativity (e.g. humorous, insightful, original) while others are scored negatively (e.g. cautious, conventional, narrow interests). These scales are still commonly used in clinical psychology and counselling settings to assess individuals. While the Creative Personality Scale has declined in use as a primary measure of creativity in research settings, it remains commonly associated with convergent validity studies carried out on new creativity measures. Its persistent relevance and usage for this purpose underlines the foundational belief among psychologists that personality and creativity are intertwined constructs.

Toward Factor-Based Approaches

Gough’s Creative Personality Scale offered, and continues to be, a relatively simple way of assessing creative potential. As suggested, this offers clinicians and diagnosticians an avenue to quickly assess creative potential. However, in research settings, the use of Gough’s scale has diminished. Two primary reasons account for the decline. First, since the scale was specifically designed to measure creative potential, there was no means to relate that underlying potential to other psychological constructs without the use of secondary measures focused on those constructs. That is, the creativity-personality connection was already assumed by the measure. Second, much of the research into personality was moving toward the use of factor-based theories of personality in studies related to other constructs. Rather than treating personality as a laundry list of distinct characteristics, psychological researchers were aiming to find higher order structure and factors that could account for variations in personality. In turn these higher order factors were being used as the level of analysis when determining correlations to other constructs.

Hans J. Eysenck was the first to apply this factor-based view of personality to the study of creativity in earnest. His first theory of personality focused on two higher order factors: extraversion and neuroticism. While this theory was developing on a parallel timeline to work of Gough and others, Eysenck applied extraversion and neuroticism to effectively create personality types in the vein of work by Katherine Cook Briggs and Isabel Briggs Myers carried out in the early 20th century.

Later he added psychoticism to his theory as a third personality factor and investigated the relationship of each factor to creativity (see Eysenck, 1993; Eysenck, 1994). His primary focus on psychoticism contributed to the controversial notion of a relationship between mental illness and creativity as well as provided grounding for theories of malevolent creativity. Results of studies on psychoticism highlighted the complexity of relationships in creativity studies in that most results are U-shaped. That is, most often, the highest creative output is generally associated with a moderate level of psychoticism with both high and low levels of psychoticism being associated with lower creativity. Furthermore, in addition to direct effects, Eysenck suggested that elements of personality often interacted with aspects of intellect and intelligence to influence levels of creative output. This has been borne out by a large body of subsequent work (see Acar & Runco, 2012). (See Bipolar Mood Disorders and Schizotypy)

The Big Five

While the theories of Eysenck moved research of personality and creativity to a more factor-based focus, his heavy focus on psychoticism held back broad applicability. There were also concerns that three factors did not fully capture individual personality. Given the interconnections of personality with a host of psychological constructs, a more complete conception of personality was desired.

Work coalesced around a Five Factor Model. Although this sort of model had been proposed earlier by Lewis Goldberg and others, Robert McCrae and Paul Costa are the researchers most commonly associated with this conception. The NEO inventory by McCrae and Costa and International Personality Item Pool by Goldberg are the most common sources of items in studies of personality. The Five Factor Model includes openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism.

Openness to experience is conceived as related to the level of one’s engagement in new ideas, the depth of discussions and analysis desired, and an interest in that which is aesthetically pleasing or enriching. Innate, natural curiosity when presented with new situations is also captured in this factor. (See Personality: Openness) Conscientiousness is associated with goal-setting, aspects of self-discipline, and one’s level of personal reliability. Extroversion is associated with people who make themselves visible or are highly interactive with others. Those high in extroversion tend to prefer a breadth of experiences rather than a depth in certain areas, if given the choice. Conversely, introversion is associated with a preference for depth and limited interaction with others (See Personality: Introversion) Those who are more agreeable think more collectively than others and are generally more flexible, sympathetic, and forgiving in their interactions with others. Lastly, neuroticism is associated with those having a high-strung nature, more nervousness, and a general lack of emotional stability.

With the Five Factor Model as the dominant conception used in personality, framing the relationship of personality to creativity in this context should be a goal to maximize applicability. The first seminal work to make this overarching connection was carried

out by Gregory Feist (see Feist, 1998). In his meta-analysis, he synthesized the results of creativity-personality studies carried out in the artistic and scientific domains. Feist examined personality differences among three groups: scientists versus non-scientists, creative versus non-creative scientists, and artists versus non-artists. Each group included over two dozen studies for comparison. His analysis brought together these studies, carried out over decades with varied conceptions of personality, into a clearer, more concise set of results. In and of itself, the re-characterization each personality measure into a Big Five framework offers an instructive guide for carrying out such meta-analysis in personality studies beyond those related to creativity.

The results which emerged confirmed previously held beliefs and raised new questions. Taken in total, the most common positive relationship to creativity was found with openness to experience. Extraversion was a relatively close second. Both personality factors were previously well-established in the creativity literature and continue to be beliefs about their connections remain foundational beliefs. The smallest magnitude effects were seen with neuroticism and agreeableness. Generally, these were negative.

Perhaps the most striking findings in the Feist analysis related to conscientiousness. In two of the three analyses, it had the highest positive effect and in the other it had the strongest negative effect. This raises important questions about the nature of personality factors and creativity conceptions. An understanding of how and why each personality factor relates to creativity, an understanding of domain specificity, an appreciation of method effects based on creativity measurements used are all needed to illuminate the personality-creativity relationship more clearly (see Puryear, Kettler, & Rinn, 2017). (See Science and Creativity)

Factors and Facets

To this point when the word factor has been used to describe an element of personality, it has been intended to connote a group or cluster of more specific expressions of personality. Sometimes in the research literature the word factor is used somewhat interchangeably with the word facet, though doing so loses a bit of meaning. Here, and in much of the literature, the word facet is used specifically to describe underlying groups of related traits. Each of the Big Five factors can be conceived as containing six underlying facets (which group into two correlated aspects). These thirty facets have slightly different names against Five Factor conceptions. For consistency the names used here will be based on the NEO Inventory by McCrae and Costa. Ultimately, while using the Five Factor model helps to determine what level of a personality factor is associated with an individual, the underlying aspects and facets provides a glimpse into the how and why of the personality-creativity relationship.

Openness to Experience and Creativity

The openness to experience personality factor contains aspects referred to as openness and intellect. Openness is further broken down into facets known as fantasy, aesthetics, and feelings. Within intellect the three facets are actions, ideas, and values. Of the Big Five personality factors, no other factor comes close to openness to experience in terms of a tie to creativity. A recent meta-analysis suggested that of the variance in creativity that can be explained by a Five Factor model of personality, openness to experience can capture roughly three-quarters of that effect by itself. The strong openness-creativity relationship is so ubiquitous in creativity studies that sometimes openness to experience itself is used as a proxy for creativity in lieu of a specific creativity index.

McCrae specifically studied the links between openness to experience and creativity and suggested three possible links for the common finding, which Feist reiterated in his seminal work (see McCrae, 1987). The first is a matter of personal interest. Individuals with high openness may gravitate toward certain sorts of open-ended tasks like problem solving and problem finding simply because they have a proclivity to tinker at such tasks. Interest breeds success which in turn breeds further interest. Second, there is ability. Individuals with higher intellect scores may be more likely to have more developed cognitive abilities allowing them to score higher on creativity measures such as divergent thinking tasks which are scored for the fluency and flexibility of ideas present in a set of responses. Third, more open people may simply want to have a broader range of experiences because they crave novel sensations. Seeking out these sorts of sensations may help them in situations requiring creativity thinking since they will have a broader base of ideas from which to draw. (See Novelty)

An analysis of the facets themselves also suggests why there might be such strong connections. Creativity is often conflated with artistic pursuits (see "Art Bias") so it seems logical that an interest in aesthetics would correlate positively with creativity. Sample items for this facet might ask an individual to rate their belief regarding the importance of art or if they simply like a certain kind of creative product, like poetry. The fantasy facet relates to imagination which also fits into a general conception of creativity. Items in this facet might question whether an individual finds themselves daydreaming often or whether they often come up with new ideas such as how to use some common object. This item is related to how well a person would do on an alternative uses task, making the likelihood of a relationship to creativity high.

Facets in the intellect aspect also show an intuitive connection to creativity. The ideas facet relates to one's interest in deep discussions or for solving complex problems. The actions facets questions one's beliefs on change and routine. Recent research suggests the openness aspect is more related to creative achievement than the intellect aspect despite the success the latter has predicting fluid aspects of intellect. Additionally, recent work by Scott Barry Kaufman and others suggests there may be differential effects of openness and intellect depending on domain (see Kaufman, 2013). Specifically, across four samples, openness appeared more related to artistic creativity while intellect was more related to scientific creativity. This dichotomy is similar to Feist's findings of differential effects for the conscientiousness factor across types of samples. While they don't deal with the usefulness/appropriateness

components of creativity, taken together the facets of openness to experience are natural kindling for sparking unique and novel ideas which are a necessary condition for creativity.

Conscientiousness and Creativity

Within conscientiousness the aspects are industriousness and orderliness. Achievement-striving, self-discipline, and deliberation are the aspects under industriousness while competence, order, and dutifulness make up orderliness. A recent meta-analysis which examined studies of personality and creativity found the mean effect of conscientiousness on creativity to be incredibly small ($r = 0.02$) across over 150 correlations including nearly 60,000 participants. For context, the predictive power of openness to experience was about 250 times greater. Remember, however, that in the Feist meta-analysis, the strongest positive predictor of scientific creativity was conscientiousness, while it was the strongest negative predictor of artistic creativity. It is possible that the observed overall effects which suggest indifference to conscientiousness when predicting creativity most likely require further investigation and nuanced understanding. By examining the aspects and facets of conscientiousness, one gains insights into how conflicting findings may come to be.

Industriousness is related to hard work, a focus on the avoidance of mistakes, and completing tasks rather than wasting time or procrastinating. Studies of scientific creativity tend to take a holistic view of a career and most often use the number of patents or publications in one's field as a measure of creative output. The attention to detail and dedication required to earn patents or publish scholarly work gives clarity to the ideas that the scientifically creative would be high on industriousness and therefore conscientiousness. While these qualities may also be needed in some artistic pursuits, the orderliness aspect can be rationalized as a stronger predictor of artistic creativity. Breaking rules and conventions combined with an openness to disorder and a bit of chaos are the antithesis of the orderliness aspect and could be argued to be at the heart of artistic pursuits. As the creative achievements of artists tend to be judged on the level of recognition received, it follows that the more novel (rule-bending), yet appropriate or useful (aesthetically pleasing), products would be judged more creative more often.

Extraversion and Creativity

Enthusiasm and assertiveness are the aspects within extraversion. Enthusiasm is related to activity-level, excitement-seeking, and positive emotions. Warmth, assertiveness, and gregariousness make up the assertiveness aspect.

While extraversion is a distant second to openness in terms of magnitude of correlation, the literature base routinely shows extraversion as a predictor of creativity. It is the second most-reported personality factor in creativity studies. In Eysenck's view (and the earlier views of Carl Jung), those with higher extraversion are more likely to seek outside stimuli as their default mode of being. This engagement with outside ideas can work synergistically with a general openness to experience leading to an increased likelihood of subsequent idea generation and/or tangible creative production. Put another way, while openness to experience suggests an interest in novel ideas and actions, extraversion suggests a willingness to take the leap of doing something about it. This logical, sequential connection is a likely explanation for the significant amount of extraversion's predictive power that can be captured by openness. Item wording may have difficulty delineating an interest in ideas from an active engagement with ideas.

Another relevant idea in Eysenck's conception notion that those high in extraversion repress or blackout details of some experiences, particularly negative ones while those who are low tend to ruminate on the details. Here is where conflicting logic prevails. Research suggests that those who can move past negative experiences or setbacks have higher levels of creative production suggesting high extraversion predicts creativity. Research also suggests that depth and thoughtfulness, particularly about one's own past experiences supports creativity meaning lower extraversion should be a better predictor. There is little research looking at the balance of these two concerns, but it can be reasoned that this conflict accounts for at least some discrepancies in the observed effects for extraversion. There may also be an issue of measurement in play as moving past negativity with continued engagement may be reflected in increased quantity of creative production. A focus on the details and personal connections to specific work may lead to an increased quality of creative production.

Specific aspects of extraversion in the Big Five conception of personality clarify the observed positive correlation with creativity. These links are more unidirectional than those associated with an Eysenck conception. Those who seek excitement are more likely to engage in novel activities and genuinely enjoy the resulting stimulation, leading to further and related engagement. Those with high extraversion are more prone to high levels of activity and positive emotions. Again, more activity leads to more production across domains. Humor is captured with the aspects of positive emotions. Humor can be nurtured through artistic and creative pursuits. (See Humor)

Other aspects of extraversion suggest a willingness to engage with larger groups of people and their ideas. At the same time, high extraversion individuals can take charge when a task needs leadership. In business settings research suggests employees are viewed as more creative when they can generate and take on ideas from others (as judged by their peers), but at the same time be willing and able to strike compromises and guide a creative project to completion (as judged by their employers). This example provides articulation for how extraversion furthers creativity in a real-world context. While the effects of extraversion are not as strong as openness, they are robust and practical, making them important considerations.

Agreeableness and Creativity

Aspects of agreeableness include compassion and politeness. Compassion is made up of trust, compliance, and altruism. Straight-forwardness, modesty, and tender-mindedness make up politeness. Of the five factors in the Big Five, none has shown smaller effects on creativity or has less extant literature than agreeableness.

The failure of aspects of agreeableness to link to creativity can be helpful in understanding the nuances how other factors and facets of personality influence creativity. Modesty and trust are two examples. Recall that high extraversion individuals take leadership roles in everyday situations. The non-relationship of modesty suggests it isn't an individual's personal opinion of taking on the role that matters, just that they do so. The non-link of trust suggests that while high extraversion interacts significantly in generative situations with others, a deeper trust of the other person is not critical - only the idea the person has. The lack of a link to tender-mindedness also suggests a parallel (lack of) focus. Overall views of personal interactions or value systems for dealing with people such as altruism simply are not as relevant for creativity as the specific ideas or products in a certain context. Agreeableness should be viewed as a factor of personality which functions on a different level than those factors which influence creativity.

Neuroticism and Creativity

Neuroticism, which is often referred to as lacking emotional stability, combines volatility and withdrawal. Self-consciousness, impulsiveness, and vulnerability combine to form the volatility facet while anxiety, hostility, and depression combine to form the withdrawal facet. Both an early focus of psychological studies of creativity on eminent creators and Eysenck's work on creativity contributed to the association of neuroticism (or lack of emotional stability) and creativity. Studies of well-known, often tortured, artists contributed to a focus on idiosyncrasies or elements of mental illness and subsequent association of neuroticism and creativity among the general public. Work by Eysenck and others linked extreme schizotypy and creativity as well (see Schizotypy, this volume) When looking at the overall literature, Feist found domain-based differences for scientist and artists though not as disparate in magnitude as those for conscientiousness. Artists were more likely to score high for neuroticism whereas scientists were more likely to score low. A more recent meta-analysis showed neuroticism to have a slightly negative effect on creativity across nearly 150 reported relationships.

As with conscientiousness, an examination of the aspects underlying neuroticism provides context to appreciate the relationship of neuroticism and creativity. Impulsiveness may play a similar role to extraversion in leading individuals to novel situations as it may help them "take a leap." Going with a thought to extremes may manifest more in artistic creativity than scientific creativity. As remaining calm in stressful situations is the antithesis of the vulnerability aspect, one can see how scientific creativity, and any project running on a deadline, such as a business workplace situation, would benefit from low neuroticism. In contrast, strong emotions such as anger and hostility may fuel creative works viewed as unique, powerful, or more meaningful suggesting a positive influence of neuroticism among artists. These contradictions necessitate further study and clarification, as well as highlight the need to consider aspects of measurement and creativity conceptions when evaluating the link between creativity and personality factors.

Creativity Conceptions and Measurement

The domain-based differences in the creativity-personality relationship framed by Feist highlighted the deeper issues of conflicting conceptions and differing measures of creativity. Jeb Puryear and colleagues examined the influence of these deeper issues while providing an update to the base of research included in the meta-analysis. Two primary questions were examined in this work: 1) How does conceived of creativity as idea-based or product-based change the relationship to personality? and 2) How does the nature of the creativity measure, as more self-reported or more externally-rated, link with changes in creativity-personality relationships? Differences across elements of divergent thinking (e.g. fluency, elaboration) and with respect to specific measures were also considered.

Measures of creative production were found to be predicted by as much as twice as much by personality factors as ideational measures. Openness to experience, conscientiousness, and neuroticism all had statistically stronger relationships when production measures were employed. Differences in openness were most striking where one measure of production, the Creative Behavior Inventory, was related to the openness factor by eight times more than the Instance Task, a measure of ideation ($r = 0.403$ versus $r = 0.164$).

Differences between creativity-personality connection were even more distinct when considering self-reported versus externally-rated measures. All five factors showed statistically stronger relationships on self-reported measures. It was reasoned that some of this could be an artifact of the measurement itself as personality is also most typically self-reported, but the extreme differences could not be completely explained away. Considering the findings of this meta-analysis, whenever one is considering the creativity-personality relationship, the types of measures and creativity conceptions must be considered. While personality theories have coalesced to a point of consensus across studies, this has not been the case on the creativity side of the relationship. Going forward, this must be considered when defining problems and research studies into creativity and personality to contextualize the work.

Conclusions: Beyond the Big Five

While the usefulness of the Big Five as a tool in personality research has not declined, over the past decade, researchers have begun to examine the utility of even higher order factors of personality. One such model is the Huge Two: plasticity and stability. Plasticity combines openness to experience and extraversion while stability combines conscientiousness, agreeableness, neuroticism. This higher order conception of personality is particularly useful in creativity studies since the factors within plasticity account for so much of the creativity predictable by personality while the stability factors have smaller and often conflicting effects.

Specific studies based on the Huge Two conception found plasticity was a significant predictor of creativity across types of measures and across domains where creativity is operationalized differently. Importantly, findings indicated that the elements of creativity that can be predicted by personality differ most clearly at this Huge Two level (see Karwowski & Lebuda, 2016). Plasticity and stability each predict creativity in their own way and capture unique effects. As research into the relationship of creativity and personality continues to evolve, one must be vigilant when considering the personality and creativity conceptions used. Some provide more generalizability. Some provide more clarity of explanation. One must know the difference.

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Personality: Creative Self-Efficacy

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Creative Self-Efficacy

Albert Bandura's work on self-efficacy has impacted a variety of fields of study. Bandura defined perceived self-efficacy as:

people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with the judgments of what one can do with whatever skills one possesses

Bandura (1986), p. 391.

Within the field of creativity studies, work on the concept of *creative self-efficacy* (CSE) has rapidly developed. Although CSE represents a relatively recent area of study in the field, work on this concept represents one of the most active areas of scholarly work by creativity researchers interested in understanding the creative self.

This entry will provide an overview of creative self-efficacy starting with a brief discussion of how the construct has been defined, how work on CSE evolved in the field of creativity studies, and current conceptualizations and measurement approaches. The entry concludes with recommendations for future research.

Emergence of Creative Self-Efficacy in the Field of Creativity Studies

One of the earliest mentions of creative self-efficacy in the creative studies literature was a 1998 article by Jonathan Plucker and Mark Runco, in which they discussed the importance of researchers identifying task-specific and task-general aspects of creative production "during each creative moment" (Plucker and Runco, 1998, p. 37).

Four years later, Pamela Tierney and Steven Farmer published an influential study entitled, *Creative self-efficacy: Its potential antecedents and relationship to creative performance* (2002). They offered a definition of the construct, developed a measure, and provided empirical evidence indicating that CSE serves as a unique and significant predictor of creative performance.

Tierney and Farmer defined creative self-efficacy as *the belief one has the ability to produce creative outcomes* (2002, p. 1138). They measured the construct with a three-item scale (e.g., "I have confidence in my ability to solve problems creatively") measured on a seven-point scale (1 = very strongly disagree; 7 = very strongly agree).

Research regarding CSE rapidly expanded to include explorations of the construct in and across various cultural contexts and domains (e.g., business, psychology, education). Much of this research used Tierney & Farmer's initial definition or an adapted version of the concept and scale. Specifically, researchers examined correlates and antecedents of CSE, the role CSE plays as a mediator and moderator, and CSE's role as a unique predictor of various creative outcomes.

Of central concern for many creativity researchers is how well measures of CSE predict creative outcomes. Previous studies exploring this issue yielded variable and, at times promising, results ranging from virtually no variance in creative outcomes accounted for by CSE to evidence of moderate effects (see Beghetto and Karwowski, 2017 for a discussion). The relationship between CSE and creative outcomes were also examined in several meta-analyses. In an extensive review of work on CSE, Farmer and Tierney (2017) discussed the results of several meta-analyses, which indicated that CSE has been found to account for 8.4% to 20.25% of variance in non-self-reported creative outcomes and 20.25% to 45.99% of variance in self-reported creative outcomes (pp. 36–37).

Current Conceptualization of Creative Self-Efficacy

Recently, creative self-efficacy was conceptualized as representing one of a family of nested creative self-beliefs, which constitute one's creative identity (Karwowski et al., 2019). More specifically, creative self-efficacy represents a particular type of creative

confidence belief that works in conjunction with creative self-awareness beliefs (i.e., beliefs about one's strengths and limitations) and creative self-image beliefs (beliefs about one's creative aspirations and sense of creative self) to comprise an overall sense of one's creative identity.

Creative self-beliefs can be further distinguished along three different dimensions (Beghetto and Karwowski, 2017): *specificity* (ranging from global to specific), *temporality* (ranging from past to future oriented), and *stability* (ranging from static to dynamic). CSE falls on the more specific, dynamic, and future oriented sides of these dimensions. CSE beliefs are activated when people are presented with a creative performance task or prompted to judge their ability to perform creatively on a specific task or specific set of broader activities in a domain. An example may help illustrate the nature and facets of CSE beliefs.

Consider an instructional consultant who is asked to come up with creative ways for introducing two scientific topics that students have difficulty learning (e.g., buoyancy and sublimation). For the first concept, the designer responds, "I'm confident I can come up with at least three creative ways to introduce buoyancy." For the second concept, the designer responds, "I'm less sure about sublimation, I can maybe come up with one creative idea, but I'm much less confident about it."

As this example illustrates, the instructional consultant's CSE beliefs are triggered by the presentation of two specific creative performance tasks. Moreover, it illustrates how creative self-efficacy differs from other forms of creative confidence on the dimensions of specificity, temporality, and stability.

With respect to specificity, although the two tasks represent the same performance domain (i.e., instructional design in science education) the particular consultant's creative self-efficacy beliefs vary based on the specific nature of each task. Indeed, CSE beliefs can vary from task to task within and across domains. Researchers interested in understanding how different tasks within the same domain may result in different CSE judgements would therefore need to measure CSE using more specific measures, rather than a more global or general measure of creative confidence (e.g., "I am good at coming up with creative solutions to problems").

With respect to temporality, CSE beliefs are future oriented beliefs. CSE pertains to a person's confidence to perform creatively on an upcoming task, whereas more global creative confidence beliefs are based on retrospective judgments of performance (Beghetto and Karwowski, 2017). Empirical research indicated that global measures of creative confidence tend to be more strongly related to past performance, whereas task-specific measures administered prior to a performance tend to be stronger, unique predictors of creative performance (Pretz and McCollum, 2014, see also Karwowski et al. in press).

This is not to say that more global beliefs have no influence on CSE beliefs. Indeed, more global and retrospective creative confidence beliefs have been found to be related to task-specific beliefs, particularly when first approaching a task (Pretz and McCollum, 2014; Karwowski et al. (2019)). This makes sense because more crystalized confidence beliefs (i.e., developed, in part, from past experiences) can be thought of as contributing to the development of subsequent CSE beliefs. However, once a person engages with a task the more immediate and proximal CSE beliefs likely will play a greater role in predicting task performance.

Finally, with respect to stability, CSE beliefs tend to be more dynamic than other creative confidence beliefs. In fact, CSE not only varies based on the nature of the task but other factors including physiological state (e.g., how one is feeling), social persuasion (e.g., whether trusted others are providing supportive messages), vicarious judgments (e.g., seeing someone who is relatable model successful performance), and various other socio-psychological factors (e.g., personal or social supports or impediments to performing a particular task) (Bandura, 1997). In this way, CSE beliefs (like all efficacy beliefs) are more than simple reflectors of prior performance, because they are influenced by a variety of situational, social, and individual factors (Bandura, 2012).

Returning to the hypothetical example of the instructional consultant, the consultant's more general creative confidence beliefs likely would influence CSE judgments for each scientific topic. However, given the differences in the two topics, the CSE beliefs would differ when initially presented with each task and those differences likely would influence CSE and ultimately performance across the duration of task engagement. Fig. 1 provides an illustration of one possible trajectory of the consultant's CSE beliefs for each task over time.

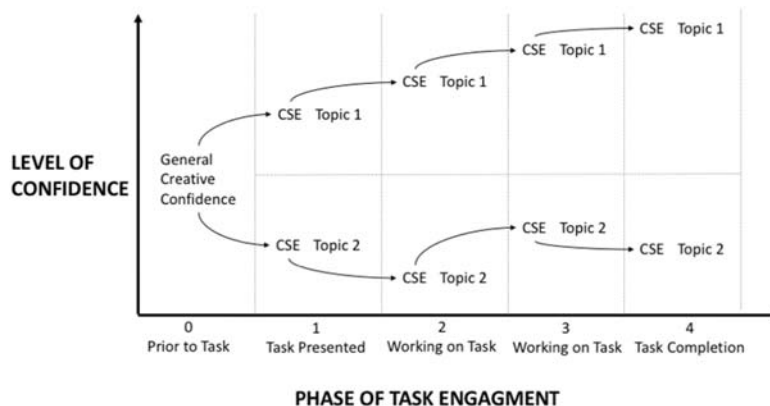


Figure 1 Hypothetical example of CSE x task variations across time.

As illustrated in Fig. 1, the hypothetical designer's general creative confidence informs more specific CSE judgments. However, once two separate tasks are presented, CSE judgments become activated. Indeed, the designer makes two different judgments of creative performance based on the two different design tasks. CSE beliefs continue to operate and fluctuate throughout each subsequent phase of task engagement. In this way, CSE plays a key role in determining whether a person will even try to engage with the task and to what extent the person will stay with the task when facing challenges (Bandura, 1997).

CSE, conceptualized in this way, highlights the more nuanced and dynamic features of this creative confidence belief, which has implications for how it is assessed in studies. The following section highlights some current approaches for studying CSE.

Current Approaches for Studying Creative Self-Efficacy

As mentioned, creativity researchers traditionally measured creative self-efficacy beliefs using more static and general measures. Consider the following global measure of, which uses three items rated on a five-point scale (1 = not true; 5 = very true) scale (Beghetto, 2006, p. 450): *I am good at coming up with new ideas; I have a lot of good ideas; I have a good imagination*

Although this global three-item measure (and scales like it) can provide some insights into people's creative ideational confidence, such measures tend to fall short in capturing the more nuanced, situated, and potentially volatile nature of CSE. Consequently, the predictive strength of such measures on creative performance likely will be weaker than more focused and specific measures of CSE. Indeed, as Bandura (2012) explained, global measures of self-efficacy usually "bear weak relation both to domain-related self-efficacy beliefs and to behavior" and thereby "have problems of predictiveness" (p. 17).

This does not mean that existing scales that measure global creative confidence have no value. Rather, the value of such scales likely will be realized when used in conjunction with more tailored and dynamic measures of CSE. As mentioned, a recent study by Karwowski et al. (2019) found that more global measures of creative confidence were predictive of more tailored creative confidence measures, which indicates that global measures do inform more task and situationally specific CSE beliefs. However, when it comes to creative task performance, more tailored CSE measures serve as stronger predictors of performance than do more global measures (Karwowski et al., 2019).

In addition to designing more tailored measures of CSE, it is also important to design tasks that have clear performance criteria. Indeed, in situations where the performance criteria of a task are ambiguous or a person has limited experience with a domain, the difference between more global and more specific measures of creative confidence beliefs likely would be negligible because the person's confidence performing a specific task would be largely based on a more general sense of creative confidence. As Bandura (2012) explained, task ambiguity interferes with people's ability to accurately judge their performance confidence.

Consequently, creativity researchers interested in developing a more nuanced understanding of CSE beliefs, likely would benefit from designing and including more tailored, specific, and dynamic measures and tasks in their studies. A brief discussion of recommendations and an example for how to design more tailored and dynamic measures and tasks are presented the sections that follow.

Designing More Tailored CSE Measures and Less Ambiguous Tasks

As mentioned, existing measures of creative confidence often lack the task and situational specificity necessary to elicit people's confidence to perform creatively on given tasks under particular situational demands. As Bandura asserted:

There is no all-purpose measure of perceived self-efficacy. The "one measure fits all" approach usually has limited explanatory and predictive value because most of the items in an all-purpose test may have little or no relevance to the domain of functioning. Moreover, in an effort to serve all purposes, items in such a measure are usually cast in general terms divorced from the situational demands and circumstances. This leaves much ambiguity about exactly what is being measured or the level of task and situational demands that must be managed. (2006, p. 307)

Creativity researchers have therefore started to recognize the importance of designing and using measures that are more tailored to the unique situational features of creative performance tasks. Again, such measures are not meant to replace existing creative confidence measures. Rather, more tailored CSE measures can be used in conjunction with more static and general measures to provide insights into how creative confidence beliefs and other related factors can work in concert with each other.

When designing more tailored CSE measures and performance tasks, creativity researchers may find it helpful to work from the following general recommendations (adapted from Bandura, 2006, 2012; Beghetto and Karwowski, 2017; Bong and Clark, 1999; Bong and Skaalvik, 2003):

- **Assess Perceived Capabilities.** *Measures should tap into people's perceived capabilities by using language focused on what people can do (e.g., "I am confident I can creatively solve three of these problems");*
- **Clarify Future Orientation.** *The future orientation of CSE beliefs should be designed into studies by making sure that measures are provided prior to (immediate or more distal) performance;*
- **Specificity of Measures and Tasks.** *Design tailored measures and tasks that assess performance in specific activity domains;*

- **Challenge and Constraints.** Items and performance tasks should include gradations of challenge or performance constraints to avoid ceiling effects;
- **Avoid Ambiguity.** Performance tasks and efficacy measures should avoid ambiguity and, instead, specify key features or levels of task performance;
- **Use Broader Range of Responses.** Use response scales that include a broad range of intervals, such as 0 to 100 or 0–10 (as they have been found to have greater predictive power as compared to scales with fewer points (see [Pajares et al. 2001](#)); and
- **Consider Dynamic Features.** When designing measures and tasks, recognize that CSE beliefs can change between initial measurement and performance; during different moments of performance; and across similar tasks within the same activity domain.

Creativity researchers can draw on the above recommendations to design more tailored and sensitive CSE measures and performance tasks for their studies. As mentioned, one way to think of creative confidence measures is that they run on a continuum from a more general to specific focus. As a result, even tailored CSE measures can range from assessing broader creative performance in a particular activity domain to specific performance on particular tasks within that domain. The key is that creativity researchers design tailored, multidimensional efficacy measures and performance tasks that represent the complexity of an activity domain and thereby elicit people's judgments of their capability to perform creatively (see Bandura, 2012).

Fig. 2 provides an example of what a CSE scale task might look like that has been tailored to a particular performance task.

As illustrated in **Fig. 2**, the CSE measure and task is tailored to a specific performance (i.e., generating a creative way to introduce the structure of matter to seventh grade science students). Moreover, this example aligns with the general guidelines discussed above. Specifically, it uses the language focused on what people can do (e.g., "Can come up with a creative way ..."), it is future oriented (i.e., CSE measured prior to performing the task); assesses confidence of capability to perform in a specific activity domain (e.g., CSE related to different concepts in teaching seventh grade science), includes various constraints that may help differentiate performance between people (e.g., grade level constraints, time constraints, spending constraints), minimizes ambiguity (e.g., provides clear description of task and performance criteria), and uses a broad range of intervals (i.e., 0–100 scale).

The dynamic features of CSE are also taken into consideration by minimizing the time from initial measurement to performance. A key benefit of designing a CSE measure tailored to be administered immediately prior to a performance task is that doing so addresses a key validity threat when it comes to assessing efficacy beliefs. Specifically, it can help eliminate what Bandura (2012) described as "temporal disparities between assessed self-efficacy beliefs and performance under conditions in which self-efficacy has changed in the interim" (p. 10). Consequently, measuring CSE beliefs in close proximity likely will enhance the accuracy and predictive performance of those measures.

With respect to assessing the creative performance on CSE tasks, researchers can use standard techniques in the field of creativity studies, such as the Consensual Assessment Technique ([Amabile, 1996](#)). Specifically, a panel of relevant domain experts (e.g., science educators) could assess the creativity of the ideas produced from this task. Moreover, this task could be used as one of several

Creative Way to Introduce the Structure of Matter to 7th Graders

How confident are you that you can come up with a creative way (i.e., unique and effective) to introduce a science unit on the structure of matter to 7th grade science students?

Here's some additional criteria:

- Your idea should introduce all the major concepts (i.e., atoms, matter, mass, volume, density, states of matter and phases of change).
- Your idea should describe a way of introducing this unit to 7th graders that takes a minimum of 30 minutes, but more than 45 minutes, and
- Each topic can use no more than \$50 of materials.

You will have a total of 15 minutes to come up with your creative idea for introducing the structure of matter.

Prior to generating your ideas, please rate your degree of confidence using number from 0 to 100 (0 = cannot do at all; 100 = highly certain can do).

<i>Can come up with a creative way to introduce:</i>	<i>Confidence (0 – 100)</i>
Atoms (definition and examples)	_____
Matter (definition and examples)	_____
Mass (definition and examples)	_____
Volume (definition and examples)	_____
Density (definition and examples)	_____
States of Matter (solids, liquids, gases)	_____
Phases of change (evaporation, condensation, freezing, melting, sublimation & deposition)	_____

Figure 2 Example of a CSE scale tailored to a particular task.

tasks to provide a broader representation of the activity domain and used in conjunction with other measures of interest to better understand the role CSE beliefs play in concert with various other related factors.

In sum, a more tailored CSE measure, designed to assess a person's confidence performing creatively on a specific task, likely will be a more reliable measure of creative confidence and, in turn, have a stronger association with actual performance.

Dynamic Methods

In addition to designing CSE items that are more tailored to specific situations and tasks, creativity researchers have also started recognizing the importance of designing studies that are more in line with the dynamic nature of CSE. Indeed, creativity researchers recognize that CSE, like many creative phenomena has dynamic properties (Corraza, 2016).

This is illustrated in the hypothetical example of [Fig. 1](#). The instructional consultant's CSE beliefs vary not only across the two different tasks, but change across the duration of task engagement.

Fluctuations in CSE beliefs makes sense theoretically. As discussed, people's creative confidence likely changes as they engage with the particular features of a performance activity. Depending on the task, their confidence may decline a bit as they encounter a surprising setback, steadily grow as they overcome challenges, and stay consistent through periods of task engagement, or some combination thereof. Consequently, researchers interested in understanding how such beliefs fluctuate within and across tasks have started to design studies using micro-longitudinal methods.

A micro-longitudinal approach refers to taking measurements with brief intervals between each measure in an effort to explore potential patterns and profiles of change in key variables of interest. With respect to CSE and related creative confidence beliefs, micro-longitudinal designs coupled with tailored tasks and measures offer researchers opportunities to identify and examine the more nuanced dynamics of CSE beliefs. Work along these lines is nascent, but recognition of using such methods to study confidence beliefs in and outside the field of creativity studies is growing ([Beghetto and Karwowski, 2019](#); [Marsh et al., 2019](#)).

Karwowski et al. (2019) for instance, used a micro-longitudinal design to explore potential changes in creative confidence beliefs and emotions across the duration of a creative writing task. Participants creative confidence and emotions were measured at three intervals: prior to, during, and following task engagement. Results from this study indicated that both creative confidence beliefs and emotions changed over the duration of the task. Specifically, creative confidence, on average, increased across the three intervals. Moreover, negative emotions tended to decrease and positive emotions tended to increase.

The findings from [Karwowski et al. \(2019\)](#) provide support for the dynamic nature of creative confidence beliefs and also suggest that as the participants in the study became more familiar and engaged with the task their creative confidence grew and, in turn, so did their positive emotions. Indeed, micro-longitudinal designs allow researchers to explore cross-lagged effects to examine directionality of relationships and, in this case the findings indicated that as participants creative confidence increased so did their positive emotions.

In sum, researchers interested in developing a better understanding of how of CSE beliefs change in and across tasks likely will find it beneficial to design and use micro-longitudinal designs in conjunction with more tailored tasks and measures. Doing so can help uncover the more nuanced and variable patterns and roles that CSE beliefs play in people's creative performance.

Conclusion

The purpose of this entry was to provide a brief overview of the emergence and evolution of creative self-efficacy research and theory in the field of creativity studies. There are few constructs that have generated as much attention in such a short period of time. This growing attention has resulted in exciting and important developments in how CSE has been conceptualized and studied.

As the field of creativity studies continues to evolve, creative self-efficacy likely will continue to play an important role in understanding factors that contribute to creative performance and the role that self-beliefs play in shaping people's creative identity and experiences.

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Personality: Grit

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Introduction

Passionate perseverance is central to most stories of creativity. One such example is Thomas Edison. Among his many creative products and nearly 2000 patents, the phonograph was his favorite invention. He refined it repeatedly over a period of 50 years. This groundbreaking technology was initially meant to be a scientific innovation for use in office work, but it was considered too complicated for ordinary office workers to use for dictation. It first recorded sound on pieces of tin foil that could be used only once. Over time, Edison was successful at refining the technology with reusable recordings and repurposing into a must-have entertainment device that families were willing to buy. This tech revolution shifted the way everyday people were able to enjoy music. Edison understood that creativity was not just producing a novel and valuable product; it took time and effort to refine and redefine his product. He also knew that it was imperative that as a creator he would be able to persuade the world that the phonograph was an innovation that they wanted to acquire. The combination of creativity and perseverance led to Edison's technological revolution.

A similar story played out in the 21st century with Steve Jobs and the Apple iPod. Jobs did not produce the first mp3 player, but the iPod was the one that made the leap to popular usage because of a combination of creative innovation and perseverance. From technological innovators like Edison and Jobs to small business entrepreneurs who need to persuade the world of their superior cupcake or consulting expertise, to artists who are forging new expressions, creativity requires the ability to persist in the face of conformity, opposition, and the indifference of the world.

Edison and Jobs are prototypical divergent thinkers because of their prodigious output of ideas. Divergent thinking has been the cornerstone of much creativity research since Guilford's clarion address at the 1950 American Psychological Association in which he called for the scientific examination of creativity in all of its complexity. Throughout the research into creativity, perseverance has played some implicit part in the conception of the construct, and the working of the creative process has clearly required some form of dogged persistence. In order to power through the identification of problems, the fluent production of novel and valuable ideas, the organization, synthesis, analysis and structuring of new ideas, and the final evaluation of which ideas to choose, it is clear that endurance is required.

The most prevalent way of measuring divergent thinking has been to determine the fluency, flexibility, and originality of ideational behavior. These tests favor those who are able to produce ideas in quantity. This has been an often-used proxy for creativity. Within this larger creative process, the creator must work through the obvious and mundane ideas, move onto the interesting and unusual, and converge upon the one that will be most fitting. Sternberg and Lubart conceived of creativity as a marketplace. A creative investor would find unknown and unpopular ideas to buy and would then invest energy and thought into refining them into marketable ideas that could be sold to the public. All of these conceptions of creativity require persistence!

In order to persevere in a creative pursuit it is critical to be intrinsically motivated and committed to the task. Some conceptions of creativity such as the pathway model, view persistence itself as one means of creativity (Nijstad et al., 2010). Historically based studies of famous creatives point to the tremendous output of prodigies who had to overcome personal and contextual barriers to become creative icons. Csíkszentmihályi's famous theory of flow (1996) is one explanation of how creators are able to push through a difficult process and manage to create. Hennessey and Amabile (1998) found that the delightful experience of flow—sustained attention to the creative process that seems to take place out of time (Csíkszentmihályi, 1996) promotes creativity through the intrinsic rewards of the process itself.

Sternberg's research found that creative individuals prefer thinking in new ways, are willing to rebel against constraints and insist on doing things their own way, and have an ability to switch between global and local thinking. These findings suggest that the types of problems and tasks preferred by creative thinkers may also require those individuals to exhibit both cognitive flexibility and perseverance in the pursuit of their goals. An important underlying assumption for personal attributes in the investment theory is that the individual can choose to nurture and exercise those attributes that lead to creativity. The attributes that Sternberg found important for creative functioning include openness to experience, risk taking, willingness to overcome obstacles, tolerance of ambiguity, and creative self-efficacy. The positive correlation between openness to experience and creativity is among the most robust findings in the literature. It seems logical that in order to become creative, one needs to be open to new experiences and ideas.

Environmental support also plays the important role of either rewarding creative ideas or devaluing them. Creativity does not occur in a vacuum; the cultural context determines whether the idea or product is indeed novel and useful. History tells us that

cultural gatekeepers do not always accept creative ideas. The individual must often persevere in the face of a resistant environment in order to sell the new idea to those who prefer status quo. An environment that is particularly nurturing of creativity can cause a flowering of creativity, such as the Italian Renaissance. However, even in a resistant or indifferent environment creativity occurs when perseverance and intrinsic motivation push the creator forward. The creator is an agent who shapes and selects environments that are conducive to the creative process. However, it is the creator's endurance in any environment that determines, in part, the outcome of the creative process.

The outcome of creativity is the production of something that is novel and useful in some way. This may be an idea, a product, a business, an experiment, a solution to a problem, a great meal, or a work of art, among many other things. These creative products may not be immediately valued in the existing environment, and the creator must find, persuade, or create a market for the useful new thing. As the magnitude of the creativity increases and the sphere of influence increases, scientific, artistic, technological, and social breakthroughs can take place (Sternberg and Lubart, 1995).

The resources that make an individual creative also can have negative effects. In school settings, teachers may dislike the presence of creative students in the classroom because they can be seen as defiant, nonconformist, and difficult. The intrinsic motivation that leads to creative perseverance may also lead to the neglect of more mundane tasks in settings where standardization and conformity are expected, and the intense focus of creative perseverance can be perceived as obnoxious or aggressive.

In closely related research, there are two additional concepts: deliberate practice and self-regulation. Deliberate practice is focused attention designed to improve performance. Think of a virtuoso musician practicing scales or a professional basketball player working repeatedly on jump shots. It takes hours of precise and deliberate practice to shape that kind of expert performance (Ericsson and Charness, 1994). This deliberate practice is also tied to the ability to self-regulate.

Self-regulation, or the ability to decide how to shape one's own behavior and reactions, is a psychological construct similar to this idea. Self-regulation is rooted in Bandura's social cognitive theory in which individuals are viewed as agents who shape and select their environments in order to accomplish personal goals. This cyclical and iterative process of self-regulation includes self-monitoring, self-judgment, and self-reaction. Self-monitoring occurs when individuals are able to pay attention to their own processes. Self-judgment allows individuals to determine the value of the efforts. Finally, self-reaction is the response to all this information. Although the desire to accomplish a goal is important, self-regulatory skills allow the individual to accomplish the goal. Self-regulation is not a fixed trait; instead, it is a skill that is developed over time and with experience. Although beginning to practice a new skill is often externally motivated by an authority figure, a self-regulated practitioner is more internally guided than externally persuaded. When there are obstacles to accomplishing a task along the way to reaching the larger goal, the success of pushing through the obstacle builds the skills of self-regulation.

Other theorists echo these findings because the importance of cognitive flexibility and perseverance is present in nearly every conception of creativity. Guilford's idea of divergent thinking as the basis for creativity was the first and most influential basis for flexible thinking. Runco built on this foundation to develop the idea of ideational flexibility as a basis for creative ideation (Runco et al., 2001). An unusual take on this idea of ideational flexibility as a contributor to creativity is the dual pathway model; this model views creativity as a function of either cognitive flexibility or cognitive persistence (Nijstad et al., 2010). In a series of experiments, students were primed for either approach or avoidance motivation conditions with instructions.

For example, for an idea generation task, those students in the approach condition were instructed: "By generating ideas, you can gain time. The more ideas you generate, the more time you gain for the second task, making it easier to do that task well." Those in the avoidance condition were instructed: "By generating few ideas, you can lose time. The fewer ideas you generate, the more time you lose for the second task, making it harder to do the task well." Their creative tasks were rated for originality as well as for flexibility and persistence. To assess cognitive flexibility, the numbers of categories that were generated were counted and those with more categories of ideas were judged to exhibit more cognitively flexibility. To assess cognitive persistence, the number of times that students switched categories was counted, and those who switched less were judged to exhibit more persistence. It was found that individuals placed in the approach motivation condition accomplished creative tasks with cognitive flexibility, whereas those who were placed in the avoidance motivation condition accomplished creative tasks with cognitive persistence (Roskes et al., 2012).

Yet in spite of this inherent need for perseverance in creativity, it has not been typically measured in the literature. Recently, a new perseverance construct has gained traction in research circles as a possible means of operationalizing the perseverance necessary to drive creativity. That construct is grit.

History of Grit

Grit is defined as the perseverance and passion to pursue long-term goals, and as such, fits well conceptually into the idea of investing in unusual ideas in spite of opposition. Grit has captured the attention of researchers, educators, and the general public. When Duckworth (2016) first conceptualized this idea, it was grounded in positive psychology and based on research into self-control and conscientiousness. Duckworth developed her scale by focusing on populations such as college students in elite universities, West Point Cadets, and young Spelling Bee Champions. It was designed to reflect the characteristics of high-achieving individuals. The two versions of the scale (12-item and 8-item) each devote half of their items to consistency of interest and half to perseverance of effort which, when combined, represent the larger concept of grit.

Grit was shown to predict markers of success such as retention or grades, over and above those outcomes predicted by intelligence. Grit is related to conscientiousness, but its emphasis on stamina sets it apart from that construct, according to Duckworth.

Individuals with high levels of grit pursue long-term goals even without positive feedback. In studies of elite groups such as Ivy League undergraduates and National Spelling Bee champions, grit has been shown to be predictive of achievement above and beyond IQ. However popular this idea has become, there are detractors who have found that the construct of grit may be based more on perseverance or conscientiousness rather than a passionate higher order personality trait (Credé et al., 2017; Usher et al., 2019).

Grit has not been examined very much among diverse populations. Although early research into grit did not find ethnic differences, a recent study among African Americans has indicated that grit is a particularly strong predictor of college grades among male African American college students in predominantly White institutions (Strayhorn, 2014). Although Strayhorn's study did not compare African American students to students of other ethnicities, the strength of the findings does prompt the question of whether or not there might be ethnic differences in grit.

Duckworth's team reported a correlated two-factor structure (consistency of interest and perseverance of effort) for the scale. The grit scale has recently been used extensively, especially in research in education as a predictor of novice teacher effectiveness and in psychology as a predictor of psychological well-being.

Grit has grown in popularity as a measure across domains, and, as a construct, its definition holds promise of being a means to predict that passion and perseverance required for creativity. There have been some mixed research results regarding the efficacy of the measure of grit as conceptualized by Duckworth. Some researchers found that grit is more of a measure of persistence than of passionate persistence. Some of this may have to do with the items used to measure the construct that seem to indicate commitment and consistency of interests over time rather than the affective aspects of passion. Some researchers have even spoken of grit as perseverant grit. Abuhassan and Bates (2015) examined conscientiousness and effortful persistence and posit that grit is more representative of persistence than passion.

True (Creative) Grit

The use of grit as conceptualized by Duckworth has started being examined by creativity researchers. Grit was recently proposed as a measure of perseverance to be used in the operationalization of the Sternberg's investment theory of creativity (Rojas and Tyler, 2018). In this study, the psychometric examination confirmed Duckworth's factor structure of two separate factors, but the recommendation to use it as a unidimensional construct. In another recent study, grit was compared to teacher reports of grit and openness to experience as a potential predictor of creative achievement (Grohman et al., 2017). This study found that grit was not able to predict creative achievement among three samples of high school students in these regression models. The researchers also proposed that grit was likely a measure of conscientiousness. Other research (Reiter-Palmon et al., 2009) has indicated that conscientiousness is not a good predictor of performance in creativity, and this provides an additional caution for grit as a measure of creative perseverance. Although there may be a shortcoming of the measure itself, there is still a need to operationalize passion and perseverance within the creative process. The definition of passionate perseverance makes sense, but perhaps grit is not the best measure for predicting creative outcomes.

The Future of Creative Grit

Future directions to be considered include finding additional measures of perseverance within the creative process. Grit is conceptualized as a passionate pursuit of long-term goals, but the factors are meant to represent interest and effort. Another measure that more explicitly measures passion might be more relevant to the creative process. Interest and effort alone do not necessarily indicate passion, although they do seem to measure perseverance.

Another challenge with the grit construct is that it is meant to be a trait-level characteristic that is mostly stable over time and is domain-general. Within the creative process, it may be preferable to find or develop a measure of creative perseverance that is domain-specific. One means of addressing this could be to add domain-specific language to the items themselves or to provide a creative context for assessing one's own grit. Other considerations for measuring perseverance in the creative process might include measuring levels of creative autonomy, intrinsic motivation, or nonconformist identity. All of these factors may contribute to the ability to persist through the challenges of creativity.

Another area of exploration for creative grit would be an examination of grit within other well-established creativity constructs. For example, one helpful tool for examining creative grit might be to look through the lens of Rhodes four P's of creativity: the person, the product, the process, and the press/environment. Perhaps grit itself should be called perseverant grit as some researchers have started to do (Usher et al., 2019).

In addition to focusing on aspects that pertain to person, process, product, or press, another important consideration is the grit necessary to accomplish different magnitudes of creativity. What levels of grit would be required to navigate everyday vs. eminent creativity? How does the developmental process of creativity correspond to the development of grit?

These are just some of the future directions that might be indicated for grit within creativity research. The need to measure the passion and perseverance required to navigate creativity is clear.

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Personality: Introversion

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Creativity and Introversion

Creativity is conceived of as one of the valuable human attributes that contributes to success in a fast-moving society. Many believe that creative people are capable of leading in the future, a world that will be full of unpredictability and complexity. For decades, a number of psychologists and educators have studied creativity from various perspectives. Understanding creativity by creative persons, processes, products and performances. Yet, creativity has been rarely studied in relation to introversion although a wide array of personality characteristics has been unveiled as personal variables contributing to creativity. Furthermore, extraversion, the opposite mode of introverted Is introversion of little importance of creativity?

This entry aims to endorse a premise that introverted personality sometimes contributes to creative performance and achievement. We first identify creativity in terms of (1) the process of creative finding and solving problems and (2) the level involving personal or every day to eminent or socially recognized creativity. We discuss the relationship between creativity and introversion by focusing on the roles introversion plays from the early stages of the creative process, and from personal to professional creativity. The creative problem finding and solving procedure is indispensable for achievement and success in domains, and particularly in business and engineering that call for innovative work in the present society. Creativity at the personal level also depends upon the creative problem solving procedure because everyone has to deal with finding and solving problems in real life settings.

This entry shows how introverted personality can help to stimulate creative thinking and leads to creative contributions. We include discussions regarding why introversion and introverted people are undervalued in creativity studies today.

Relationships Between Creativity and Introversion

What Literature Says About Introversion, Introverted People, and Creativity

Despite the ongoing argument whether personality is one's stable internal trait or developmental characteristic, personality is deemed the underlying basis of behavioral differences for individuals. In the studies of creativity, a various types of personality have been addressed as a stimulating force of creative achievement, yet little is known about introversion. The following section discusses introversion and creativity according to the three themes: Conceptions of introversion, characteristics of introverted people, and introverted characteristics found among professionally to eminently creative people.

Conceptions of Introversion

The conception of introversion was first introduced by Carl Gustav Jung in the early 1920s as a mode to explain one's attitudes towards the world. Jung identified introversion and extraversion in terms of the location of one's sources of energy, namely the internal world for introversion and the external world for extraversion. Some researchers defined introversion as the opposite personality facet of extraversion. For example, a dimension of introversion versus extraversion is included as one of the four personality modes on the *Myers-Briggs Type Indicator* (MBTI), which explains one's personality type in terms of responding to and interacting with the world around oneself. Sixteen personality factors similarly identified introversion versus extraversion as the tendency to move away from versus towards interactions with other people. Eysenck (1990) similarly defined extraversion in accordance with behavioral characteristics that involve sociability, impulsiveness, activity, carelessness, liveliness, jocularity, etc., as related traits. Introversion in his model is placed in the opposite end of extraversion identified by low levels of impulsiveness and sociability.

Introversion has been discussed according to the state of cortical arousal (Eysenck, 1967). Eysenck differentiated introversion and extraversion in terms of a state of cortical excitability that affects one's outgoing behaviors and social interactions. He claimed that introverts have higher cortical excitability than extraverts because the former has a lower threshold for arousal in the ascending reticular activating system (ARAS) than the latter. Corcoran (1964) found that after having lemon juice, profuse salivation was reported more from the introverted than extraverted people because the introverts had a lower state of ARAS activation. The low activation in the ARAS is associated with a low intensity of alertness and feelings (e.g., tired, weary, drowsy, powerless), while high activated ARAS triggers alerted, energized, courageous, and vigilant state of mind (Young and Pigott, 1999). Other results reporting introverted people's high level of cortical arousal confirm lower alpha rhythm amplitude, shorter latency of Wave V and faster conduction time between Waves I-III and I-V on the brainstem auditory evoked responses; and faster ABR wave V latency found among the introverts compared to the extraverts.

Differences in cortical arousal accounting for variances between the introverted and extraverted people originate from one's intentional attempt to hold an appropriate degree of arousal when responding to a wide array of stimuli (Eysenck, 1967). Introverted people are thus likely to avoid outer stimulations in order to keep their arousal to a minimum level (i.e., low arousal threshold), and extraverted people are the opposite, thereby being prone to pursuing excitement and social activities to increase their arousal. In this regard, the introvert outperforms in a low-stimulus environment (e.g., quiet mood, alone time), and his/her behaviors are manifested in a reserved and self-contained manner.

On psychometric scales, introversion is also measured as the opposite personality mode of extraversion. On the *Myers-Briggs Type Indicator* (MBTI), one of the four subscales measure one's inclination for introversion versus extraversion in terms of one's orientation towards attention. Individuals who prefer introversion are inclined to pay attention to their own inner state, ideas, thoughts, and emotions, and those preferring extraversion focus on the outer world. Eysenck and Eysenck's Personality Questionnaire (EPQ) measures the dimension of extraversion/introversion in terms of the level of impulsiveness and sociability. Individuals with higher score on extraversion are likely to be sociable, dominant, outgoing, and risk-taking; seek excitement; and act extempore. While, introverted people have the opposite characteristics with low levels of impulsiveness and sociability. Lastly, the NEO Personality Inventory, well known as the Five-Factor (or Big Five) model of personality measures patterns of one's behaviors according to the five dimensions of personality. In the model, extraversion is related to a great intensity of enthusiasm, and introversion is identified with low enthusiasm.

Characteristics of Introverted People and Creativity

Introversion has been rarely studied as an independent personality mode but has been addressed as the characteristics of individuals identified as introverted and/or as the opposite characteristics of extraverted people. Research has documented that introverted people are quiet, humble, and good at managing uncertainty; prefer to learn by listening; and feel comfortable working alone. They are highly sensitive, cautious in processing information; and persistent in solving complicated problems. In particular, introverts are likely to gain energy internally more than externally; spend considerable time preparing and incubating thoughts and ideas; and carefully respond to outer stimuli. They have a genetic disposition to longing for solitude because solitude invigorates to keep contact with one's own world, encourages to speculate on ideas, and stimulates creative imagination and innovation. Thus, introverted people prefer to have quality time thinking about their own ideas before sharing them with others and take action.

The above mentioned introverted characteristics were found among creative people (Feist, 1999 for summary), and particularly those who accomplished professional to eminent levels of creativity. Research showed that introverted tendencies, such as having alone time and attentional focus with great intensity, followed by a certain degree of social isolation are crucial for creative achievement. Introversion and social aloofness were found more for creative scientists than less creative scientists. This result supported the previous study that revealed introversion as the distinctive characteristic of creative scientists. Similarly, among the professional artists, securing time and space for being apart from other people was indispensable to producing creative ideas and artwork. The capacity to be alone encouraged creative artists to think, learn, imagine, and innovate, and solitude was therapeutic in the process of creative artwork. Ericsson and colleagues also reported that the highly achieved violinists spent substantial time alone for practice and that the best violinists practiced intensively more than the other groups of violinists (i.e., good violinists, music teachers) during the entire period of musical talent development. Deliberate practice is possible when one procures alone time to intensely concentration on work. It enables one to take apart from the routine and get playfully engaged in work, so that s/he can move beyond the current realm of stable performance that upholds the status quo and prohibits creative performance (Ericsson, 2006).

Researchers supported that deliberate practice is imperative to professional accomplishment (see Ericsson, 2006; Hayes, 1981; Kaufman and Kaufman, 2007). World class performers in various domains, such as chess, sports, arts, and science, for example, spent a decade of intensive preparation for creative achievement. Gardner's analysis of seven creative geniuses substantiated how intensive efforts for 10+ years devoted to creative work contribute to eminent achievement. Kaufman and Kaufman reported that it took an average of 10 to 13 years for writers to produce a masterpiece since they had started publishing work. Also, some creative scientists and writers were reported to spend 10 years reaching the ages to produce eminent work since their first productions. It is not clear if all these creative people were identified as introverted. It is likely that their introverted inclinations to long for personal time and solitude contribute to forming a sense of inner peace, facilitate self-reflection, and make it possible to get engaged in deliberate practice which ultimately fosters creative accomplishment.

Results are split whether introverted people lag behind socially. Examples include that the majority (2/3) of creative architects were identified as introverted. Yet, they liked to exercise control over other people, enjoyed being in a leadership position, and had

good social skills. In contrast, creative professionals in science and business were found to be introverted, preferred to be alone, and sought solitude.

Some anecdotal evidence endorses introversion as one of the distinctive personality characteristics found for creative people who obtain outstanding reputation for their creative work or lead today's business world. Examples include Ludwig van Beethoven, Wolfgang Amadeus Mozart, Franz Schubert, Johan Christian Bach, Michael Jackson, Vincent van Gogh, Pablo Picasso, Charles Darwin, Albert Einstein, Daniel Libeskind, Steve Wozniak, Mark Zuckerberg, Franz Kafka, William Shakespeare, Virginia Woolf, Kareem Abdul Jabbar, Emma Watson, Emma Stone, Mohandas K. (Mahatma) Gandhi, and Angela Dorothea Merkel. These are all creatively eminent and introverted people whose work have had a tremendous impact on the world. The following are some of the famous introverts who are quiet, shy, nervous, sensitive; prefer to be by oneself and work alone; and concentrate on work with great intensity, persistence, and passion.

Steve Wozniak, an American inventor and technology entrepreneur, well known as a co-founder of Apple, the world's largest information technology company, is a quiet business innovator. In contrast to another Apple co-founder Steve Jobs, an extraverted creative genius, Wozniak came up with ideas on his own, and believed in the importance of thinking and working alone. "I don't believe anything really revolutionary has ever been invented by committee ... I'm going to give you some advice that might be hard to take. That advice is work alone, not on a committee, not on a team," said Wozniak (Foran, 2015, p. 12). In fact, generally, Wozniak was reported to be by himself and worked alone until he developed his first Apple computer.

Michael Jackson, an American singer, songwriter, and dancer, was one of the most popular entertainers and best-selling musicians of all time. He was famously known as a very shy and private person who got nervous and would not (dare to) talk to people if he did not know them well. Christine "Coco" Decroix, a singer who translated Jackson's song "I just can't stop loving you" into French language recalled the moments when she met with Jackson.

At the beginning, I thought I was disturbing him and that my presence was too much. It's very embarrassing. And then, gradually, after he saw me a few times with Quincy, he started looking at me. Then he said, "Hello." He got used to me. He needs to be comfortable. When this happens, he is extremely caring though he is still worried whether everything goes well, if people are happy. This is the most considerate guy I have ever met. And what people don't know is that he has a lot of humor ("More about Michael," 2012).

Emma Stone, an American actress and an Oscar Award winner for her leading role in the 2016 film "La La Land" was a very nervous child and confronted a debilitating shyness and numerous panic attacks in childhood. She admitted that acting helped her to overcome her anxiety triggers because it enabled her to be less nervous about her own fears and granted her an outlet to reduce her anxieties through interactions with other people. She said, "Before any interview, I have to sit with myself for 5 min, breathe, and get centered because I get so nervous. Interviews are kind of like therapy except all your answers are being written down and printed. I always want to be on the other side of it" (McShane, 2017, p. 5).

Daniel Libeskind, a world-renowned architect who won the competition to be the master plan architect for the reconstruction of the New York City World Trade Center site, needs time alone for his creative work. He said that securing time apart from beloved family and other (significant) people is valuable because it serves as a foundation for his creativity. Time for reading poets, playing the musical instruments, taking a stroll down the street, and lying down under the tree were some of examples he referred to as imperative to build creative architecture (Meyers and Gerstman, 2007).

Mark Zuckerberg, an American technology entrepreneur who is known as a co-founder and a current chairman and chief executive officer of Facebook, an American online social media and social network service company, is one of the most famous introverted entrepreneurs. He is described as a classic introvert who lives in his own world staying up all night, focusing his attention on a subject he is interested in, and working alone. "He is shy and introverted and he often does not seem very warm to people who don't know him, but he is warm ... He really cares about the people who work here [Facebook]" said Facebook COO Sheryl Sandberg during the New York Times interview. Sandberg has been a great supporter of Zuckerberg who was portrayed as socially aloof and visibly nervous in public interviews. She has offered him social guidance to compensate for his introverted and sometimes less charismatic personality (Helft, 2010, p. 8).

Charles Darwin, an English scientist who is very well-known for his work on the science of evolution, and Franz Kafka, a Bohemian Jewish writer and one of the key figures in the 20th century literature are other influential introverts who spent a considerable amount of life time in solitude. As a child, Darwin enjoyed long, solitary walks and fishing for hours by himself. Kafka's extreme introversion was manifested in describing his desire to be alone while devoting to work. He said, "You [his fiancée] once said that you would like to sit beside me while I write. Listen, in that case I could not write at all ... That is why one can never be alone enough when one writes, why there can never be enough silence around one when one writes, why even night is not night enough." (Cain, 2012, p. 86).

The above examples support that introversion was evidently found among these eminent people and influenced their creative thinking and performance that have transformed their own domains and entire human life. Whether introversion is inherited or has to be a precedent condition for one's creativity is yet inconclusive.

Mechanisms of the Creative Process and Introversion

Understanding creativity by means of the model of creative process helps to identify contributing factors from start to end of creation. In the creative process model, numerous factors are involved in discovering and solving problems in a creative manner. These include a range of intrapersonal attributes, including personality, but few studies examined introversion and its engagement in the creative process.

Models of the creative process have suggested a stepwise procedure that provokes creative thinking. The renowned Dewey, Wallas, Osborn-Parnes, and Isaksen, Dorval, and Treffinger models are good examples that account for the creative process involving multiple steps. For instance, Wallas's model consists of preparation, incubation, illumination, and verification processes. Osborn-Parnes' model included mess finding, data finding, problem finding, idea finding, solution finding, and acceptance finding as the core steps for solving problems in a creative manner. Isaksen and colleagues expanded the process stages by adding some, and suggested the creative problem solving procedure in the following order: Constructing opportunities, exploring data, framing problems, generating ideas, developing solutions, and building acceptance. Sawyer similarly proposed an eight-stage model comprising finding and formulating the problem, acquiring knowledge, gathering related information, having time for incubation, generating ideas, combining ideas, selecting ideas, and externalizing the ideas.

Although the number of stages varies according to the models, each similarly includes time for preparation and incubation at the initial stage of the creative process. In relation to introversion, is the creative process, particularly the early stages favorable to introverts? What aspects of introversion contribute to the creative problem solving procedure? Does introversion push one to move towards on the final stage for a creative solution?

The preparation time allows individuals to explore ideas and get information to find and construct problems. The subsequent period of incubation encourages to associate a wide variety of knowledge and information with one another while taking some time off from the routine performance. It facilitates the problem solving process by searching and connecting relevant information and fading out obstructive links that fixate one's minds. In regard to creativity, the benefits of incubation include that it provides individuals with time to relax, shift attention away from the problem, and facilitate to engage in problem-solving activities. Some argue that break and relaxation during the incubation period allows to diffuse one's attention from false information and continue to work on the problem. It also provokes insightful and intuitive thinking (see [Sio and Ormerod, 2009](#)).

Anecdotal evidence supports that creative people (e.g., Charles Darwin, Daniel Libeskind, Franz Kafka, Franz Schubert, Ludwig van Beethoven, Marie Curie, Vincent van Gogh Virginia Woolf, etc.) had a period of incubation as their work habits or during the creative work process. The famous Archimedes' relaxation in the public bath, Charles Darwin's riding in a horse-carriage, and Albert Einstein's playing violin or taking a nap are some examples of incubation activities that urge post-incubation creativity.

Introversion promotes creative thinking from the early stages of the creative process. During these periods, a person is apt to internalize what s/he is interested in, needs time for discovering and finding a problem, and contemplates on generating ideas. Attentional focus is requested to select a few creative ideas out of the many before implementing the selected ones. A broad scope of attention during the preparation and incubation periods helps to make associations among the free floating colliding ideas, while focused attention prompts to make connections among linearly woven ideas. After the incubation period, the narrowly focused attention allows to combine and select some of the ideas crucial for solving the problem. As lonely thinkers like many creative people, introverts are not only fond of securing personal time and space but also good at holding to put devoted efforts into a few areas of their interest and dissipating energy for non-related task. Although they are often regarded as socially isolated and lack compelling leadership, their inclinations to have alone time, internalize problems, and look for clues via attentional focus encourage them to think, imagine, and garner knowledge and information for creative solutions ([Kaufman and Beghetto, 2009](#)).

It seems that the above mentioned introverted personality is instrumental in the initial stages of the creative process that ask for discovering a problem and generating ideas, and the middle stages for converging ideas to find potential solutions. Yet, results are split if introverted people benefit from brainstorming, one of the most used idea generation strategies based on divergent thinking ability. Introverted people are able to produce a quantity of ideas spurred by a wide array of cognitive and emotional activities that occur in the preparation and incubation periods. At the same time, they may want to focus intensively on producing a few quality ideas because they tend to carefully proceed with information and behave prudently in response to the outer stimuli.

The sequential creative process model posits a series of linear steps to reach creative solutions, asking for divergent thinking to convergent thinking abilities at each stage. However, each stage is not fully independent of one another nor strictly formulated but rather embraces both divergent and convergent thinking abilities. What aspects of introversion enhance divergent and/or convergent thinking in the creative process? How does introversion facilitate both types of creative thinking? Neither empirical nor anecdotal evidence has answered these questions explicitly. Further discussions regarding what stage in a certain domain one enters at a certain period of creative development are needed to better understand how introversion contributes to one's creative accomplishment.

Levels of Creativity and Introversion

Creativity starts within the individual who intentionally or unintentionally puts personal meanings to his/her own creative process and in everyday life. Because personal and/or every day creativity is inherent in one's expression of creativity and appears in a wide array of daily activities that one is engaged in, it is not dependent upon domains nor external judgment for creativity. However, when one wants to move beyond the scope of personal creativity, s/he must be able to achieve professional expertise. A professional creator does not have to transform the present domain but has an extensive influence on the domain via his/her achievement.

For individuals with personal but perhaps not professional creativity, introverted tendencies to think internally, obtain personal time and space, work alone, and focus on a few selected creative ideas may help stimulate both a number of and a quality of creative thinking and behaviors in the experience and context of daily life. On a professional level, creative experts spend quality time to

concentrate on and promote their expertise by having at least 10 years of practice. Thus, intentional preparations with alone time are likely to contribute to the attainment of professional creativity and gearing one towards on the next level of creative eminence.

Creativity Today and Introversion: Myths and Facts

Creativity today is conceived of a complex of systems involving individuals, domains, and fields. The system approach encourages to conceptualize creativity based on the manifestation of value-laden products and performance acknowledged by the field and more so by the entire society. The final stages of the creative process consist of verification, acceptance, evaluation, implementation, communication, and/or similar modes of activities. All these procedures facilitate to produce outstanding creative outcomes (i.e., eminent creativity) that are accepted all across the domains to have a significant impact on human life.

Individuals of creative eminence are able to sell their ideas and products to other people higher than their invested time and efforts on the outcomes. They must be good at convincing others, building and expanding their professional networks, and promoting their creative products for the betterment of the society. They are also capable of leading other people and making a difference for the outer world using their widely acclaimed creation.

Introverted people were reported to have lower interpersonal competence and poor communication skills compared to extraverted people. Yet, introverted people do not always lag behind socially. In fact, a number of famous creative people compensate for their introversion by the help of other people and/or their creative work. Some of the creative introverts (e.g., Steve Wozniak, Mark Zuckerberg, Hilary Clinton, Rosa Parks, Eleanor Roosevelt, Moses in the Bible, etc.), for example, demonstrate balanced leadership by placing the opposite partners of extraverted and/or sociable characteristics in their professions. Others also develop interpersonal competence by overcoming social discomfort by pursuing their professional goals with persistence (e.g., Albert Einstein, Charles Darwin, Franz Kafka, Wolfgang Amadeus Mozart, J. K. Rowling, Emma Stone, etc.). Creative achievement at a professional to eminent level is possible if one's introversion moves beyond a personal disposition to become a social attribute. Being socially capable is thus one of the most compelling abilities needed in the final stages of creative development. Because of these credentials, highly achieved creative people look like extraverted more than introverted.

On the other hand, there is a deeply rooted misperception about introversion in the society where the culture of personality leans toward extraversion. Many are aware that today's world favor certain prototypes of personality, such as a left-brained extravert and a socially motivated person. Unfortunately, introverted people are not acclaimed for their dominant personality characteristics. They are generally portrayed as shy, peculiar, lonely, abnormal, timid, nervous, socially maladjusted, problematic, and isolated although these are not the constituents nor qualifications of introversion.

Introverts and extraverts mainly differ in terms of their preferred manners of social interactions. Introverted people like to share their interest areas with a few close friends and avoid conflicts, while extraverted people enjoy socializing with others and dislike being alone. All these matters of difference do not warrant that introverts are interpersonally problematic. Negative stereotypes about introversion and introverts, particular in relation to social skills are rather recent. Many highly creative people are introverted, but they are not always socially incapable. They show the highest creative achievement via efficiently implementing their ideas and selling them well to others and the world.

Conclusion

In the studies of creativity, introversion has not been a major theme nor regarded as a contributing personality to creative achievement. Using the creative process model, this entry discussed how introversion fosters creativity from the beginning stages of creative thinking and from personal to professional levels. A number of highly creative people happen to be introverted across the various domains. What they need for creative accomplishment are personal time and space for thinking and work, a certain degree of solitude, and intensive practices in their areas of creativity before reaching the top. Although it is out of scope to conclude that introversion is a sufficient condition leading to creative achievement, we conjecture that introversion is embedded from the start of creative production.

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Personality: Openness

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The Openness to Experience Trait

Personality traits are identifiable as dimensions capturing individual differences in human behavior. Specifically, personality traits organize thoughts, feelings, motivations, and interactions with the environment in defined patterns, which are consistently displayed over time and that highly influence the individual's values, expectations, behaviors, and self-perceptions. Among the fundamental dimensions of personality, Openness to Experience refers to a continuum of individual differences in the desire for and processing of experience, based on the depth and breadth of consciousness, and leading to a constant drive toward exploration and enlarging exposure to reality (McCrae and Costa, 1997). Individuals high in Openness to Experience are described as original, imaginative, unconventional, curious, intellectual, and creative. The main theoretical framework under which this trait is conceptualized is the Big-Five model, which identifies five fundamental dimensions in personality: Extraversion, Agreeableness, Conscientiousness, Emotional Stability (vs. Neuroticism), and Openness to Experience.

Labeling Openness (to Experience): Underlying Factors

Openness to Experience captures a broad and complex ensemble of characteristics that render it very difficult to grasp which arguably makes it the most controversial of the personality traits. As a symptom of this complexity, this personality dimension took on many different names over time, among them Culture, Cultured, Intellect, Openness, and Openness to Experience.

The label Culture/Cultured was used to capture in this trait facets such as intellectual, curious, imaginative and polished, suggesting that these aspects of personality could be the result of education. According to this label, education would act on personality through exposure to a broad range of ideas, active engagement in arts and science, and aversion toward accepted norms and values. However, even if education (especially a liberal education) is congenial to individuals who are high in Openness, research has proved that education plays only a minor role in the development of this personality trait. This evidence, along with the fact that the Culture label is not apt to identify a clear factor in several analyses, led to abandoning this term.

A second label that has had considerable diffusion is Intellect, which derives from the lexical tradition and identifies the tendency toward reasoning, building new knowledge, and understanding. In fact, the engagement of open people in a variety of experiences along with their tendency to spend time in activities requiring/inducing acquisition of information (such as reading all genres of literature) leads them to build a wider general knowledge. As a consequence, individuals high in Openness are characterized by higher crystallized intelligence. Even if initially Intellect was proposed as an alternative labeling to Openness to Experience, the current research is providing evidence of the fact that Openness and Intellect are distinct but equally central aspects of this trait (DeYoung et al., 2012). The twofold nature of the Openness to Experience trait can be therefore captured by its two main factors: Openness (also referred to as the Experiencing factor) and Intellect. The Openness factor has been associated with the appreciation for aesthetics, with deep experiencing of sensations and feelings, with absorption in fantasy and imagination. The Intellect factor is

associated with a tendency toward broad abstraction, intellectualism, enjoyment of philosophy, and engagement with abstract and semantic information.

In addition, a third factor was recently proposed, Open-mindedness captures non-traditionalism, seeking variety, and acceptance of diversity. While the Openness/Intellect factors reflect the individual's vision of the world (physical or intellectual, respectively), Open-Mindedness can be seen as the breadth of the world's impact on the individual. This subdivision into two or more constitutional factors produces a call for further research to achieve a more precise and distinctive structure and terminology. Irrespective of the adopted subdivision of Openness to Experience into factors, usually this trait is explored as a global dimension of the Big-Five model, in order to capture its complex phenomenological essence. When this does not produce ambiguity, the label can be shortened to Openness trait (not to be confused with the Openness factor). Indeed, Openness trait and Openness to Experience trait can be found interchangeably in the literature, and we adopt the short form in the following. (See Personality: Big-Five Personality Characteristics)

Measuring Openness in the Questionnaire Tradition

The Openness trait is defined in the questionnaire tradition as a set of lower order facets, which depend on the selected measurement instrument. While there is substantial agreement on the centrality of some facets (e.g., aestheticism), others tend to appear in a scattered manner.

A recent systematization of the facets defining the Openness trait has been provided by sorting and meta-analyzing eighty-five scales (Connelly, Ones, Davies, & Birkland, 2014). Eleven facets emerged from this analysis to be theoretically and empirically related to Openness: Aestheticism, Autonomy, Fantasy, Innovation, Introspection, Nontraditionality, Openness to Emotions, Openness to Sensations, Thrill-seeking, Tolerance, and Variety-seeking. Only four facets emerged however to be pure and related uniquely to this trait: Aestheticism, Openness to Sensations, Nontraditionality, and Introspection.

It is important to highlight that normally Openness is measured with questionnaires assessing all five personality traits in the Big-Five model. However, specific instruments have been developed to measure this specific trait independently, such as the Openness to Experience Inventory (Woo et al., 2014) which measures six facets (Aesthetics, Curiosity, Depth, Intellectual efficiency, and Tolerance) organized in two general factors, Culture (i.e., Experiencing) and Creative intellect (i.e., Intellect).

Openness and Creativity

The personality of highly creative individuals is often described as imaginative, adventurous, bored by routine, incredibly curious, able to see possibilities that others miss. As mentioned before, these characteristics are all elements constituting the archetype of those individuals observed and considered to define the Openness trait. Indeed, since the start of the theoretical discussion on Openness, this trait has been intrinsically related to creative behavior. In fact, the terms "creativity" or "creative" can be found in the wording of several items in the measurement scales for this trait. Not surprisingly, reviews and meta-analyses have identified Openness as the personality trait more strictly associated with creativity within the Big-Five model (Feist, 1998; Puryear et al., 2017).

Moreover, recent data showed that Openness is one of the most important variables defining lifetime creative achievement, i.e., frequency of episodes of creative success in the course of one's lifetime. Specifically, Jauk et al. (2014) demonstrated that Openness together with the individual's creative potential and intelligence predict creative achievement, possibly through a reduction in the behavioral threshold to engage in creative activities, and the consequent increase in success rate. Openness would then interact with the individual's intelligence level, with results showing that only people with intelligence above a threshold and performing several creative activities, thanks to their Openness, can reach high creative achievement levels.

Openness within Different Conceptualizations of Creativity

Given the fundamental relationship between Openness and creativity, it must be stated that its magnitude varies across different possible conceptualizations and operationalizations of the creativity construct. A sharp distinction exists between the study of creative potential (the capacities and predispositions toward possible future creative success) and that of creative achievement (the track-record of creative success in a lifetime). Typical measures of an individual's creative potential include divergent thinking tasks, whereby indexes such as originality, fluency, flexibility, or elaboration in the production of alternative ideas can be derived.

Considering creative achievement in a lifetime, measurement instruments such as the Creativity Activity and Accomplishment Check list (CAAC) derived from the Creative Behavior Inventory (CBI; Hocevar, 1979), or the Creative Achievement Questionnaire (CAQ; Carson, Peterson, & Higgins, 2005) are used. These instruments, referring to creative success in domain specific and/or everyday activities, are self-report check lists on the quantity (number or frequency) and quality of creative efforts and their recognition. The relationship between Openness and creative potential or creative achievement is also influenced by the person(s) estimating the creative products: self-assessed versus others-assessed approaches may lead to quite different results. Exemplary of the first category is the self-report method, of the second the Consensual Assessment Technique.

Creative Potential Versus Creative Achievement Measures

As mentioned above, divergent thinking tasks are the most accepted measurement instruments that gauge an individual's creative potential and in particular his/her ideational ability. Originality of the responses and fluency are the most adopted indexes in the quantification of divergent thinking performance. Independently of the adopted index, research showed a consistent positive association between Openness and divergent thinking performance. A systematic review by Ref. [Puryear et al. \(2017\)](#) showed that when the relationship between personality and creative potential versus creative achievement is explored, Openness emerges as the most strongly and positively correlated trait with both measures.

However, a diversified influence of Openness on the two types of measures appears to emerge: when variance is explored, Openness explained creative achievement measures at more than twice the rate of creative potential measures. This result underlines the importance of the type of conceptualization and related operationalization of the creativity construct in the analysis of the creativity–Openness link. In particular, it appears that the Openness trait plays a more important role in real-life creative achievements than in divergent thinking tests.

Self-Assessed Versus Others-Assessed Measures

Another key element affecting the relationship between Openness and creativity is the adoption of either self-assessed or others-assessed approaches. In general, Openness emerged as the best predictor within the Big-Five model of both self-assessed and others-assessed creative performance. However, since self-assessed measures are person-centered, just as personality inventories are, one could suppose the existence of a stronger relationship between self-assessed rather than others-assessed measures of creativity and personality, and in particular Openness.

Experimental data support this expectation: as reported in the meta-analysis by Ref. [Puryear et al. \(2017\)](#), Openness explained almost three times the variance of self-assessed creative performance as opposed to others-assessed results. This result should be taken with caution, as it may emerge from a partial overlap between the self-assessment of Openness and the self-report measure of creativity. Indeed, items in the Openness profilers contain terms such as creativity, imagination, ideas, etc. Also, the higher correlation emerging between self-assessed measures of Openness and creativity may be imputed to the self-report modality itself, which in a fundamental way relies on the individual's sensitivity to appreciate characteristics and idiosyncrasies in his/her own behavior. In other words, a common variance in these self-assessed measures could be generated via the individual's self-image or personal identity, which in turn is related to the concept of creative self-beliefs.

Creative Self-Beliefs

Self-beliefs are intended as individuals' convictions about their own abilities and potential. Three forms of creative self-beliefs have been explored in creativity studies: self-rated creativity (individuals' assessment of their creative abilities or potential), creative self-efficacy (individuals' beliefs in their own capacity to manage and sustain creative challenges), and creative personal identity (deeply rooted into the relevance assigned to creativity in one's self-image).

Openness has been shown to be significantly associated to all of these forms. A distinction has been proposed in the literature between core personality traits and surface self-concept characteristics: while the former would be rooted in genetic characteristics and as such less sensitive to culture and environment, the latter would be more exposed to context-related influences. In this view, personality traits are considered basic tendencies, while surface self-concepts are characteristic adaptations. This distinction is necessary since the apparent strong association between Openness and all forms of creative self-beliefs called into question whether measures of creative self-beliefs are actually able to measure anything else but Openness itself. However, a recent meta-analysis by [Karwowski and Lebuda \(2016\)](#) showed that the association between Openness and creative self-beliefs is indeed positive and consistent across studies, but perhaps not as strong as previous research seemed to suggest.

The strength of this relationship is significantly affected by the adopted type of self-concept measures, with stronger associations emerging when using domain-general versus domain-specific measures of creative self-beliefs. Moreover, the choice of the Openness measurement tool has an impact: shorter scales lead to higher correlations than longer scales. These results seem to confirm the relative independence of the two types of constructs. At any rate, these findings call for further study about the effective relationship between traits and self-beliefs, and in particular whether the Openness trait could be considered the cause of the much more malleable creative self-beliefs.

Explanatory Mechanisms in the Relation Between Openness and Creativity

Openness is therefore the personality dimension most deeply interconnected with the creativity construct, and this trait can be observed through a variety of experience enlarging behaviors. Recent research has therefore dedicated attention to understanding whether the relationship between Openness and creativity can be explained through specific behavioral mechanisms, which might act as a bridge between this personality trait and creative performance. The intention is to pass from the study of Openness as a generic tendency to the analysis of specific mechanisms related to Openness, with the purpose of identifying specific behavioral/physiological vehicles linking this trait to creativity. This research field has produced numerous explicatory models, suggesting mediator and/or moderator roles for defined behavioral or cerebral mechanisms in the association between Openness and creativity.

Cognitive and Cerebral Mechanisms

The main cognitive characteristic of individuals high in Openness is the tendency to direct their attention to a variety of knowledge domains and cultures, which can be identified as breadth of interest. When involved in a specific task, they possess an ability to notice and give attention to information that is not considered mainstream, but that vice versa could be defined as unconventional, or sometimes even irrelevant.

Batey and Furnham (2006) hypothesized that the relationship between Openness and creativity could be due to a lower tendency toward filtering out irrelevant information, which can then enter into the creative thinking process. According to this hypothesis, people high in Openness would have less selective attentive filters, letting in a larger portion of reality in comparison to closed-minded people, and this would turn out to be instrumental in enabling a larger pool of associations during ideation.

Indeed, the relationship between attention and creativity is a classic theme in creativity studies with a cognitive approach. Past results showed for instance that breadth of attention is a main correlate of creative performance. Individuals with wide attentive focus allow inputs from irrelevant stimuli because their attentive filters are not selective enough to prevent the inclusion of unwanted information into the thinking process (Necka, 1999). (See Breadth of Attention)

Similar results emerged in the study of the association between latent inhibition and Openness, showing that individuals with higher Openness levels are characterized by lower inhibition scores, testifying easier access to complexity, i.e., a wider span of information. Starting from this scientific evidence, a recent study explored whether attentive processing could act as a moderator in the relationship between Openness and creativity (Agnoli et al., 2015). Identifying as *irrelevance processing* the elaboration of apparently irrelevant information, and exploiting an eye-tracking set-up, it was possible to show that irrelevance processing allows those people high in Openness to reach superior creativity levels as measured by both their performance in a divergent thinking task and by their self-report measure of creative achievement. Specifically, the statistical interaction between irrelevance processing and Openness in influencing creativity outcomes was shown, confirming that attentive processing is a central cognitive mechanism in the relationship between Openness and creativity. These results seem to suggest that the relation between a core personality trait, such as Openness, and creativity can at least partially be conveyed through a specific attentive mechanism, i.e., irrelevance processing.

In a search for neural correlates underlying the Openness-creativity relation, a neurophysiological study explored the anatomy of specific brain structures as a possible explanatory mechanism (Li et al. 2015). This study showed that the regional gray matter volumes (rGMVs) of specific brain regions were associated with trait creativity. In particular, the rGMV of the right posterior middle temporal gyrus (pMTG) was positively correlated with individual trait creativity. It was suggested that the contribution to creativity of large rGMV in this region can be explained by the semantic processing functions typically associated to the lateral temporal cortex: semantic processing of metaphors, conceptual integration and comprehension, and novel associations.

Interestingly, this study also showed that Openness could act as a mediator in the association between the rGMV in pMTG and trait creativity. Openness emerged indeed to be related to both the rGMV in pMTG and trait creativity, and to reduce their association via a partial mediation. Lin et al. (2015) proposed that this mediation role could be related to the Openness-enabled induction in the right pMTG of specific patterns of cognitive processing associated to imagination, curiosity, and fantasy. Openness would therefore stimulate the cognitive functions related to the pMTG, which in turn are strictly related to creative performance.

Emotional and Motivational Mechanisms

The creative process is permeated by emotions (Agnoli and Corazza, 2019). Emotions emerging from failures or negative feedback, as well as from success, can give specific directions to the process, increasing or decreasing for instance the willingness to engage in further creative activities. The ability to maintain high intrinsic motivation, i.e., an enjoyment in the activity, is believed to be essential to succeed despite negative external evaluations, making the difference between giving up and persisting in the creative process. In this framework, emotional intelligence plays a relevant role, starting from the ability to self-monitor one's emotional state. Research indicated open people were more prone to pay attention to inner feelings. Moreover, Openness is associated to higher levels of intrinsic motivation. Given this evidence, the role of emotion and motivation has been explored as a possible further exploratory mechanism in the relationship between Openness and creativity.

Ivcevic and Brackett (2015) found an interaction between Openness, which they intended as a personality disposition toward creativity, and emotion regulation abilities in predicting students' creativity as assessed through nominations by peers. While emotions regulation *per se* does not appear to help people in being more creative, it does seem that this ability can enable the reach for higher creativity levels in open individuals. Since people high in Openness have a dispositional preference for new ideas, and are in general more willing to take risks in order to realize these ideas, they are more likely to be exposed to the emotions permeating a creative process. Emotional regulation emerged therefore as an important interactive variable in the management of emotions by individuals high in Openness, including feelings associated to failures, poor external evaluations of one's work, or the elation emerging from great success.

Another fundamental component that drives the entire creative process is motivation. Motivation is necessary to activate the cognitive and attitudinal resources that allow individuals to face the challenges of the creative process. Most creativity researchers agree in particular on the importance of intrinsic motivation, which has been shown to interact and relate to the Openness trait in predicting creative performance and achievement. Prabhu et al. (2008) for example demonstrated that intrinsic motivation partially mediated the relationship between Openness and creative self-perception: open individuals score higher in their self-evaluation of creative abilities due to their characteristic of being intrinsically motivated toward creative activities. These findings were also

supported in a study by [Tan et al. \(2019\)](#) who showed that the Openness–creativity relationship is mediated by the connection between intrinsic motivation and engagement in creativity-related activities. In other words, individuals who are high in Openness tend to have higher scores in creativity self-evaluation; thanks to their increased intrinsic motivation which in turn increases their engagement in creative activities.

Openness is therefore very useful but not sufficient for a highly creative self-identity; according to these findings, individuals must also engage in creative activities for the sake of personal satisfaction, be ready to invest significant resources and take risks. The role of intrinsic motivation emerged as central in the explanation of the Openness–creativity relationship not only when creative self-perceptions are explored, but also when creative achievement is used as a criterion. In the study by [Agnoli et al. \(2018\)](#), intrinsic motivation interacted with Openness in the explanation of students' creative achievement both inside and outside of the school environment. These results interestingly show that only in the presence of a sufficient level of Openness does intrinsic motivation act as a significant predictor of creative achievement in the considered environments. Irrespective of the context, therefore, people should be open-minded enough to use their intrinsic motivational tendencies to achieve creative success.

Socio-Cultural Influences on Openness and Creativity

The above discussion has been laid out taking the point of view of a single individual, endowed with an inventory of personality traits, and engaged in creative activities, with little concern for the surrounding socio-cultural environment. This approach is definitely reasonable and scientifically sound, given the focus on a specific personality trait and its influence on an individual's creative potential and achievements.

On the other hand, a systemic view on the creativity construct requires that the individual's experience and characteristics are embedded in an environment, which does play a fundamental role in providing opportunities, pressure, feedback, challenges, and so on. In this view, personality traits do not predetermine one's experience, but they interact with the relevant social and cultural situation in order to generate a dialogue out of which a unique experience is instantiated. This reasoning is in line with a socio-cultural manifesto for creativity ([Glaveanu et al., 2019](#)), according to which creativity is a culturally mediated action, and the role of personality characteristics should therefore be mapped onto this systemic view of a complex construct. Questions addressed here include the following: What are the cultural influences on the Big-Five model of personality, and in particular on the Openness trait? What is the influence of cultural characteristics such as collectivism and individualism on the creative construct and its relationship with the Openness trait? Considering the social organization of cultural activities into knowledge domains, in particular distinguishing between artists and scientists, should Openness effects be considered as domain general or domain specific?

Cultural Influences on the Big-Five Model of Personality

It is important to start this discussion by stating immediately that a large body of scientific literature appears to confirm the Big-Five model emergence in various cultures, the observation of similar patterns of developmental personality change in adulthood, as well as the possibility to predict patterns of acculturation effects on personality for immigrants across different cultural milieus. This amount of evidence justifies the hypothesis that there exists a significant biological foundation underlying the definition of the core personality traits. ([McCrae and Costa, 1997](#)).

It is then possible to perform studies that try to correlate cultural values and models of personality traits across cultures, an exercise notably carried out by [Hofstede and McCrae \(2004\)](#), who compared different hypotheses and conclusions based on the same data but taking the points of view, respectively, of cultural psychology or of the psychology of personality. In this study, Openness turned out to be connected to various dimensions of culture, such as for example power distance (the extent to which less powerful members of society accept and expect that power is distributed unequally): individuals living in low-power distance countries tended to score higher in Openness than in high power distance countries.

However, caution should be exerted in claiming universality of Big-Five personality factors across cultures; indeed, out of the five factors, Openness appears to be perhaps the most problematic in cross-cultural application ([Triandis and Suh, 2002](#)). As an example, administration of personality profilers in Hong Kong and China by [Cheung and Leung \(1998\)](#) led to confirm Neuroticism, Extraversion, Agreeableness, and Conscientiousness factors, with the sole exception of Openness. There could be many reasons behind this result: poor quality in item translation; lack of relevance of an item in a cultural milieu; response style differences, including different social desirability standards; test format problems; trait-level and trait-structure differences. This means that even if the Big-Five model does not emerge in a specific culture, this evidence is not sufficient to conclude that it is not applicable: this apparent difficulty in falsifying the Big-Five theoretical framework is a clear hurdle from the scientific point of view, to be addressed by future research.

Individualism and Collectivism: Influence on Openness and Creativity

In order to investigate those macroscopic aspects that might have an influence on the distribution in a population of the Openness trait, it is useful to define two opposing poles in the characterization of cultural trends: individualism versus collectivism. Whereas in a collectivist culture individuals have close mutual links and see themselves as part of one or more social structures

(family, organization, and nation), members of an individualist society see themselves as independent entities who rely on themselves for success and dignity.

A further specification, which is in fact orthogonal to the individualism–collectivism axis, is that of vertical versus horizontal societal structure: a vertical structure implies large power distance, strong hierarchies which are difficult to climb, whereas when horizontal values prevail the structure is flat and there is great emphasis on equality and fairness. These distinctions are significant in terms of how people see society around them and themselves in the environment. Persons living in a collectivist society, more vertical than horizontal, see the environment as stable and themselves as malleable, to fit in the collective. In these conditions, personality traits and their influence on behavior emerge with more difficulty. Openness is not as powerful as a predictor for creative performance. Vice versa, people in an individualist milieu, more horizontal than vertical, see themselves as having stable attitudes, personalities, and rights, and they may act to change the environment. It is here that personality traits emerge in all their relevance, and particularly the relationship between Openness and creativity.

Since the Big-Five model was born in the milieu of Western culture, which is prevalently individualistic, it is reasonable to expect that there may be differences when its application is proposed to the more collectivist-oriented Eastern countries (Triandis and Suh, 2002). At the same time, Western culture is also the environment in which creativity studies have initially been developed, and several notions in creativity studies have been questioned regarding their cross-cultural applicability, starting from the definition of creativity itself. All in all, it is safe to state that socio-cultural aspects of Openness, creativity, and their interrelationship deserve further scientific investigation.

Domain Generality for Openness in Creativity: Artists Versus Scientists

Within every culture there are significant distinctions in terms of domains of knowledge, and the statistical distribution of individual differences might be affected by the fact that one is belonging to a specific knowledge domain. The question here is whether the Openness personality trait and its relationship to creativity can be considered to be a domain-general item or conversely if it should be treated under the light of domain-specific distinctions. Clearly, the outcomes of this analysis depend also on the semantic distance between the knowledge domains under study.

Two domains that are typically considered to be sufficiently distinguishable are those of sciences and the arts, even though it would be incorrect to build a sharp dichotomy between these two fields. In order to come to conclusions with sufficient validity, it is useful to resort to meta-analyses of personality studies in the domains of scientific and artistic creativity, such as that conducted by Ref. Feist (1998). There, lifetime creative achievement and the Big-Five model were used to perform three orders of comparison: scientists versus nonscientists, creative versus less creative scientists, and artists versus nonartists. The most important result out of this meta-analysis is that, irrespective of measurement approaches and taxonomies used for personality and creativity, creative individuals in both domains were characterized by high levels of the Openness trait, with a very significant effect size. In other words, these results appear to suggest that Openness can be considered to be a domain-general requirement for creative performance and achievement, at least in both sciences and the arts.

A Prime Example of Openness: Leonardo da Vinci

It can be argued that polymathy is perhaps the most evident behavioral sign of high levels of Openness. R. Root-Bernstein & M. Root-Bernstein (2004) showed that polymathy is not an isolated feature but a common characteristic of highly successful creative achievers, such as Nobel Prize winners. This discussion of the Openness trait is therefore concluded by describing in short the characteristics of the person that can be argued to have been the greatest polymath, as well as creative genius: Leonardo da Vinci. Notably, Leonardo is also the first example brought up by Ref. McCrae and Costa (1997) of a person possessing the archetypical set of mental, emotional, and attitudinal traits that characterize people that are high in Openness, justifying the necessity for this factor in a model of personality.

Leonardo was born in Vinci on the 15th of April of 1452, the illegitimate son of a notary and a peasant woman. Had Leonardo been a legitimate son, he would have simply become a notary, a closed destiny for what might have become a closed mind. He spent his early childhood freely roaming in the Tuscan countryside, open to wild experiences under the mild guidance of his uncle Francesco, a modest philosopher who invested a long time in discussing nature with the young Leonardo, teaching him to appreciate both its beauty and its perfect equilibrium. It can be argued that these early years were fundamental in shaping the vast curiosity and Openness to Experience of Leonardo.

When he reached the age of 10, Leonardo moved to Florence and at 14 years old he entered the Bottega del Verrocchio, a thriving workshop at the peak of Renaissance times, in the good company of great artists-to-be such as Botticelli and Il Perugino. There, Leonardo was engaged in all kinds of activity, from painting to sculpture, from drawing to solving engineering problems, from manufacturing objects to discussing the principles of life. Without formal education, Leonardo defined himself “homo senza lettere,” an unscholarly man, but there could have been no better training if the goal was that of becoming a polymath.

Working in Florence, Milan, Mantova, Venice, Rome, and finally Amboise, Leonardo never stopped enlarging the breadth of his interests, until the very end of his life, and this relentless cross-domain activity led him to achieve world’s highest creative success in nearly 20 different disciplines: painting, drawing, sculpture, music, scenography, special effects design, cartoon design, prose writing, anatomy, optometry, optics, botany, geology, geometry, engineering invention, aerospace engineering, mechanical

engineering, hydraulic engineering, robotics engineering, military engineering, civil engineering, architecture, city planning, cooking, and nutrition sciences. Leonardo died on May 2, 1519, i.e., approximately five hundred years before the time of writing this encyclopedia, and he remains the unmatched exemplary figure exhibiting the highest level of Openness and creativity ever achieved.

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Personality: Risk-Taking

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Creativity involves the generation of novel and useful products, ideas or procedures. Creativity has long been inherently associated with risk reflecting the idea that risk-taking is integral to creativity or that creative people are risk takers (Prabhu, 2011, p. 319). Accurately speaking, it seems more appropriate to treat creativity and risk-taking as two independent but relevant constructs, wherein risk-taking can be considered a key personality characteristic of creative individuals (e.g., Feist, 1998).

Risk and Risk-Taking

Risk, a key component of uncertainty, often involves objective risk as estimated by “experts”, and subjective risk as estimated and experienced by everyone. The distinction between subjective and objective risk can be illustrated by this example—if a particular mushroom dish is believed to be healthy, then the objective risk of it being poisonous will not be experienced as a (subjective) risk until the body responds to the poison; if, however, an individual subjectively believes that there is a risk involved in an action, such as eating a poisonous mushroom, then the objective riskiness of that action becomes unimportant for determining whether the person is a risk-taker (Trimpop, 1994). That is, subjective risk is more important than objective risk in determining whether a person is a risk-taker. Only if an action is considered or known to bear negative consequences, can it be experienced as a risk. Yates (1990, 1992) specified three key components of risk, as follows: (1) the involvement of loss; (2) the significance of the loss—the perceived utility of the loss outcome or the weighted size of credible loss; (3) the uncertainty linked to the loss—the probability of loss (as expected) and the variance of the probability distribution over the probability of all potential consequences.

The concept of risk-taking propensity has important implications for theoretical research on risk-taking and risk activities, and for giving practical insights into the motives underlying individual-level choices about engaging in risky behavior. Risk-taking is any consciously or unconsciously controlled action taken where there is perceived uncertainty about its outcome and/or the possible benefits or costs to the physical, economic or psycho-social well-being of oneself or others. Although risk-taking can be situational and dispositional, the majority of existing studies imply that risk-taking is (pre-)dispositional as opposed to situational. Importantly, risk-taking was traditionally considered to be a single personality trait, similar to impulsiveness (Eysenck and Eysenck, 1977). However, this view is gradually being replaced through the recognition of distinct risk-taking components highlighting its multi-dimensional and domain-specific nature. Accordingly, risk-takers are individuals who prefer riskiness and to take risky actions where the consequences and/or probabilities of outcomes are entirely unknown or only partially known. Moreover, this preference goes beyond a single, specific situation, showing instead considerable cross-situational and even cross-domain consistency. That is to say, risk-takers tend to prefer risky actions or choices in a variety of different situations.

As a personality trait, dispositional risk-taking, also termed risk-taking propensity, could be regarded as a facet of extraversion as identified by the Big-Five personality theory. As a multi-dimensional construct, it is influenced by a considerable number of traits and emotions: positively by such traits as extraversion and openness, and negatively by neuroticism, agreeableness and conscientiousness. In addition, individual differences in negative affect or emotions, such as anxiety or worry, have a negative impact on risky decision-making, making an individual more risk-averse. In sum, risk-taking is a relatively stable, multidimensional personality trait or disposition that can be generalized from an individual’s behavior choices or attitudes toward riskiness in one situation to many situations, or at least to the majority of situations within the same domain.

Risk-Taking Calculation and Assessment

The appropriate measurement of risk-taking has long been a subject of debate among scholars in personality psychology, management science, decision science, economics, and other fields, reflecting the perceived theoretical and practical significance of this construct. Risk-taking varies according to the individual; that is, everyone has a different level of risk-taking, influenced by a number of factors. Understanding the determinants of risk-taking is not only of theoretical interest but can also provide practical insights for financial regulatory requirements. Studies indicated that individual risk-taking is influenced by previously experienced personal outcomes, gender, age and outcome feedback, as well as an individual's risk attitude and risk perception. Risk perception is an individual's estimation of the risk inherent in a situation, and commonly involves the processes of objective computation and subjective estimation of risk. Accordingly, risk perception is essentially a subjective process, in which individuals assign different riskiness weight to the same (objective) event. Some people may have a relatively positive attitude toward risk while others may have a negative perception. According to classic portfolio theory (Markowitz, 1952), a person's risk-taking depends on their risk attitude and estimates of the expected return (expected utility) and volatility (variance) of a business (i.e., the probability of the loss of the investment). Ultimately, risk taking is calculated by the curvature of the investor's utility function, as follows (see Weber et al., 2012):

$$\text{Risk taking} = f(\text{expected return, risk, risk attitude})$$

In this equation, risk attitude is the trade-off between risk (the probability of such a gain) and expected utility (return), and is directly assessed by asking the investor. To measure an individual's risk-taking, numerous studies have developed many instruments and paper-and-pencil scales. In the following section, four commonly used measures for assessing individual risk-taking are introduced.

Risk Preference Index (RPI)

The RPI, developed by Hsee and Weber (1997, 1999) is a commonly used measure for assessing individuals' preferred level of risk-taking, with good cross-national validity. An RPI score is computed from responses to a set of 14 questions, one-half of which relate to a gain situation, the other half to a loss situation. Respondents are required to rate their level of risk-taking for each situational question on a Likert scale ranging from 1 (most risk-averse) to 8 (most risk-seeking). In the gain situations, if a participant chooses the non-risky option in all seven questions, her/his RPI equals 1 (most risk-averse). If she/he chooses the risky option in all seven questions, her/his RPI equals 8 (most risk-seeking).

Domain-Specific Risk-Taking Scale (DOSPERT)

The DOSPERT was developed as a domain-specific measure of individual risk-taking, in order to examine situations in which the same person displays different risk-taking attitudes in distinct domains—for example, one in sport and another in finance. Popularized by Kogan and Wallach (1964), it has been used extensively to identify the general risk-taking propensity of individuals. It is a standardized questionnaire consisting of 30 questions across five different domains of risky behaviors (Ethical, Financial, Health/Safety, Recreational, and Social) (Blais and Weber, 2006). Each domain typically contains six items, and individuals are required to rate the likelihood of engaging in risky activities on a seven-point Likert scale ranging from "extremely likely" to "not at all likely" (different versions of this scale have different scoring methods, e.g., some of them use a five-point Likert scale (Kamalanabhan et al., 2000)). Higher scores on the scale suggest greater likelihood of engaging in risk-taking. Sample items include: "Passing off somebody else's work as your own" (ethical), "Disagreeing with an authority figure on a major issue" (social), "Bungee jumping off a tall bridge" (recreational), "Driving a car without wearing a seat belt" (health/safety), and "Betting a day's income at a high-stake poker game" (financial). In accordance with the risk-return and expected utility framework, DOSPERT also contains simple measures of risk perception (from "extremely risky" to "not at all") and expected benefits (from "substantial benefits" to "no benefits at all") on a seven-point Likert scale. "Risk perception" responses are seen as reflecting an individual's gut-level assessment of risk, whereas "expected benefits" responses measure the degree of benefit a person stands to gain from such "risky activities" (Tyagi et al., 2017).

Choice Dilemmas Questionnaires (CDQ)

The CDQ, developed by Kogan and Wallach (1964), encompasses 12 vignettes depicting a daily situation in which a dilemma choice must be made between a desirable "bird in the bush" and an even more attractive "bird in the hand." The questions are selected from different domains of everyday life, and then combined into a single score that purportedly reflects an individual's level of risk-taking. For instance, in a scenario in which participants are asked to decide whether they would leave a stable job to take a better-paying job at a company with uncertain prospects, they must indicate what probability of success would be sufficient to make them choose the risky alternative—e.g. 1 in 10, 3 in 10, 5 in 10, and so forth. A low score indicates risk-taking, while a high score implies risk aversion or risk avoidance. This instrument has been used extensively in a variety of studies examining risk-taking in groups or individuals. As for its reliability, Kogan and Wallach (1964) reported an internal consistency of 0.62 for

females and 0.53 for males. Although these indicators are not very high, this questionnaire remains the most frequently used measure of risk-taking.

Balloon Analogue Risk Task (BART)

The BART, developed by [Lejuez et al. \(2002\)](#), is a relatively new, computerized, laboratory-based measure with high ecological validity, that assesses actual risk-taking. This measure is very similar to real-world risky behavior, in which individuals can be rewarded up to the point at which they experience a reversal as a result of an unknown risk. In this task, a series of computer-animated balloons are presented one at a time, which participants are asked to inflate by repeatedly pressing a “pump” button to administer puffs of air. As participants click this button and the simulated balloon increases in size, they earn increasing amounts of money (which accrues in a temporary bank). Each balloon can burst at any moment, according to an array of N numbers. Participants must decide how often to keep pumping and risk the balloon bursting, or stop pumping the balloon at any point during the trial. If they do so before the balloon bursts, all the points or money she/he has accumulated in her/his temporary account is transferred to a permanent account (by pressing the money collection button); however, if the balloon bursts (with a “pop” sound), all the points accumulated in the temporary account are lost. After each trial, a new balloon appears, until the designated number of balloons (trials) have been completed. Participants are not told about the likelihood of the balloon bursting ([Sela et al., 2012](#)). Once the entire test is completed, several indicators can be extracted, including the total number of exploded and unexploded balloons, the distribution of unexploded balloons, and the number of times of clicking the balloon immediately following a burst balloon. Previous studies demonstrated that all these indicators are closely associated with risk-taking and the test has been validated as reflecting dispositional risk-taking.

Other measures, including The Benthin Risk Perception Measure (BRPM), The Impulsiveness Questionnaire, The Game of Dice Test (GDT), The Iowa Gambling Task (IGT), The Delaying Discounting test (DDT), the Roulette Betting Task (RBT), and the Cambridge Gambling Test (CGT) were used in previous studies to measure individual risk-taking. The four instruments listed above each have their own advantages and can be used selectively in different studies according to research approaches and requirements. For example, the BART provides data on individual general risk-taking with high ecological validity, whereas the DOSPERT can assess an individual's domain-specific risk-taking.

The Roles of Risk-Taking in Creativity

The role of risk-taking in creativity is an issue of growing interest. Traditionally, risk-taking is seen as being integral to creativity. Consequently, some well-known theories and measures of creativity included a risk-taking component in their construct. For example, the Williams Test of Creative Propensity (1980) consists of a subscale with risk-taking as a personality trait or disposition.

Taking sensible risks is considered a prerequisite for triggering or nurturing an individual's creativity according to the investment theory of creativity ([Sternberg and Lubart, 1992](#)). However, several recent studies have refuted such a simple association between risk-taking and creativity. Generally speaking, the development of novel ideas is risky because new ideas imply violating or changing the previously established order and associations. A newly created thing or novel idea may be original, however, its appropriateness or usefulness is less salient and may be difficult to determine. Many creative ideas may be rejected because of they are perceived as irrelevant or impractical. Often ideas which turn out to be extremely important are rejected because they are so different. This tendency is especially true when individuals experience uncertainty-related risk ([Mueller et al., 2012](#)).

The individual creator in the arts must grapple with the risk of limited earnings or poverty while they learn their craft with no guarantee they will ever make a living. The mature working artist has to deal with taking appropriate risks in the market including trying new ideas. Startup companies take big risks since most of them fail while successful companies constantly face the need to innovate.

The empirical data available on risk-taking in creativity is limited and still open to debate. Creativity is not an entity but a complex construct encompassing multiple heterogeneous components, such as divergent thinking and convergent thinking. In two studies, [Tyagi et al. \(2017\)](#) presented a diverse range of creativity measures combined with two risk-taking scales—the DOSPERT and Roulette Betting task—individually to 64 and 417 volunteers respectively. Their results showed that creativity assessed using the Creative Achievement Questionnaire (CAQ), Runco's Ideational Behavioral Scale (RIBSs), and Gough's Creative Personality Scale (CPS) was associated with high risk-taking propensity in the social domain only. Neither performance on the thinking measure (i.e., alternate uses task, AUT) nor that on the compound remote associate task was related to risk-taking, suggesting that while it may be appropriate to treat risk-taking as a trait, at least in the social domain, it is not homogeneously associated with creativity. Moreover, the likelihood of risk-taking in the social domain only was the strongest predictor of creative personality and ideation scores but did not predict other measures of creativity.

Another study conducted in a Chinese cultural setting—in which individuals are considered to be less risk-averse, especially to material or financial risks—found that risk-taking measured using the RPI indicated that dispositional risk-taking was positively correlated with divergent thinking and negatively correlated with convergent thinking ([Shen, Hommel, Yuan, Liu, & Zhang, 2018](#)). For another, risk-taking is a construct of multidimensional nature, considering risk-taking not only as disposition or personality trait, or a situational facilitator motivating an individual's creative effort, but also as a state construct—willingness-to-take-risks

(WTR)—conceptualized as an extension of Sitkin and Pablo's (1992) treatment of risk-taking propensity. In contrast to risk-taking propensity, WTR is a state (rather than a disposition or tendency), is context-specific (applying to the specific case of creative behaviors as opposed to decision-making in general), and includes the specific consideration of the possibility of potential negative outcomes. Many factors might influence the association between risk-taking and creativity so there may be no simple or homogeneous role of risk-taking in such complex activities or creative behaviors.

Conclusion

A review of the existing literature demonstrates the risk-taking nature of creative individuals as well as the "risky side of creativity." However, many questions remain concerning the role of risk-taking in creativity. One key reason is that creativity is a multifaceted construct straddling multiple phases (e.g., preparation-incubation-illumination-verification or generation-appreciation/evaluation), and in successful entrepreneurs risk-taking may play a key role alongside other personality traits such as openness, extraversion, and curiosity. Similarly, risk-taking is not a simple, homogeneous construct, despite always being regarded as a distinguishing factor of creative individuals. The role of risk-taking in creativity may be modulated by many factors, such as emotion and individual difference variables such as goal orientation. In the same way that risk-taking is defined as the trait of being afraid of the unknown and arousing curiosity, the unknowns of risk-taking in creativity should not make creative individuals afraid, but should instead stir their curiosity and drive to clarify it for themselves.

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Photography

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Uses of Photography

Photography has served many purposes, including journalism, advertising, portraiture, and social media. It has also been used extensively within psychological science. One of the most historic distinctions in psychology is that of stimulus (or antecedent event) and response (or resulting behavior). As stimuli, photographs have quietly contributed much to psychological science and therapies over the last six decades. Photographic stimuli have served a variety of research uses, in studies of emotion and facial recognition, physical attractiveness biases, as well as appearance and stereotyping. Studies of physiological and attentional responses on occasion have used emotionally intense photographic stimuli. Photographs have also been useful in the study of race, life narratives, gender roles, gender effects in smiling and social connection, and the sharing of cell phone images. More broadly, social scientists have used photography to appreciate varying educational environments, inner-city life, and homelessness.

In the clinical realm, photographs have been reported useful in psychoanalytic treatment, family therapy, self-esteem and identity-oriented counseling, behavior therapy, grief therapy, rehabilitation counseling, adolescent alcohol use, and various art therapies. A rapidly expanding area of study is that between social media or selfies and body image, body dissatisfaction and eating disorders. Indeed, the last 10 years has witnessed exponential growth in clinical reports that incorporate photography, although generally not with a focus on creativity. Whereas clinical uses hope to facilitate communication or self-reflection, research uses of photography seek to impact human behavior be it physiological arousal, affectional, anxiety, or prejudicial responding. Combined with originality, this capacity to impact is a key component in most definitions of creativity—namely that the creative product has utility or works for some purpose. Clearly, photographs as stimuli have many psychological uses. But only recently has the photographic response been studied, and as such it has become a tool in the study of creativity.

Creativity stems from the interaction between personal characteristics, process, and environment to produce novel and useful products understandable within a social context. Subsequent sections will describe the different components of photographic creativity: the process of creating photographs, the personality and aptitudes of the creative photographer, the photograph as creative product, and the environment/press or the social aspects of creative photography. First, we touch on what makes photography unique among creative arts.

Unique Aspects of Photography

Photographic documents are not the creations of an idealizing imagination that responds to the imperfections of reality with a dream of beauty. Instead, they are the trophies of a hunter who looks for the unusual in the world of what actually exists and discovers something exceptionally good. Rudolf Arnheim, 1986.

Photography is a relatively new domain. The first successful photographic process, a daguerreotype, was a creative technological breakthrough in 1839. The development of photography solved several problems of representation in drawing and painting (e.g., depiction of foreshortening or unusual angles) and influenced painters, for example Degas. It can be argued too that photography took over painting's imitative purpose and opened it to a higher level of abstraction.

Unlike other visual media, for example painting, photography is distinctly utilitarian due to its less arduous process. Nowadays, given the ubiquity of cell phone cameras, there are millions of amateur photographers whose primary goal is not to produce high quality creative works but to preserve and share personal memories. The ease of making photographs deflated the value of photography as an artistic medium in the eyes of the art world. Despite the continued skepticism about the value of photography as art, by the 21st century, it has been established as part of the art market. Photographs have become valued and widely collected as status symbols. New York's Museum of Modern Art (MoMA) started its photography collection of modern photography in 1930 and has

expanded it to over 25,000 photographs. Experts in the art world mark the early to mid-1970s as the beginning of recognition of photography as an art form with the start of regular and dedicated sales of photographs at major auction houses.

Technique and tools dictate creative behaviors: photographers are often in motion and painters are not. Photographers' work involves anticipation, constant scanning, vigilance, situation awareness, bursts of activity and production of many images, most of which are never shown to the public. Photographers subtract or distill images through the outside-in approach. Thus, creative problem solving in photography stresses subtraction and selection. Photographers capture and select already existing slices of reality through responding to *decisive moments* (Cartier-Bresson, 1999). Compare that to the intense additive, multi-layered creative process involved in writing a novel or composing an opera.

The capture and selection of images can also imply a *violence metaphor* where photographers "point-and-shoot" a scene (Sontag, 1977), trap a moment in time or a *theft metaphor* as in "take the picture" (Milgram, 1977). There is a fear of being photographed. It may be linked to the violence metaphor or the potential unfairness of the exchange between the photographer and the photographed. This potential for photographic exploitation can be seen especially in travel photography where researchers observed that the photographed populations may fear that photographers will use the images in a detrimental way. Some are also fearful of cameras due to religious prohibitions or superstitions.

Technical improvements in photography over the years have shortened processing times and produced increasingly higher quality images. With a quicker and more economic production of durable photographs, technical details became less important and content became more important. Photography paradoxically became both an art form and a way to mass produce snapshots. It is an extremely democratic art form.

Process of Creating Photographs

The camera is a sketch book, an instrument of intuition and spontaneity, the master of the instant which, in visual terms, questions and decides simultaneously. In order to give a "meaning" to the world, one has to feel involved in what one frames through the viewfinder. This attitude requires concentration, discipline of mind, sensitivity, and a sense of geometry. It is by economy of means that one arrives at simplicity of expression. Henri Cartier-Bresson, 1999.

I have a way to photograph. You work with space, you have a camera, you have a frame, and then a fraction of a second. It's very instinctive. ... in this fraction of a second comes your past, comes your future, comes your relation with people, comes your ideology, comes your hate, comes your love—all together in this fraction of a second, it materializes there. Sebastiao Salgado (From 2007 LA Times Interview).

Empirical research on photographic expertise is scarce. However, guidelines used by photography educators can provide insight on the creative process in photography. The process of creating a photograph involves research, experimentation, persistence but also accident and luck. Pasteur's famous quote "chance favors the prepared mind," while applicable to all domains requiring mastery, is particularly relevant to photography where often a split second separates master work from products that are common and uninteresting.

The creative challenge in photography is to show reality and yet modify it; make it look original but communicate with viewers. Just as in other creative domains, successful photographic process needs to be scaffolded with years of training in technique, equipment, design principles, subject matter, selectivity, and presentation. There is an abundance of instructional literature on how to take compelling photographs. Photography training involves learning to work with light, color and composition within the image frame, visual design and technical tools like figure/ground, lines, shapes, focus, exposure, rhythm, motion, depth, visual weight and optics. To bolster creativity, photographers might experiment with unusual lighting, angle, exposure, camera placement, filters, lenses, composition, and layout. As compared with amateur photographers, professional photographers are more likely to detect and describe photographic flaws (as defined by a separate sample of professional photographers; Serafin, 2013). These include lighting, lens, composition, and subject flaws. Photographic expertise allows for creating images high in both technical quality and aesthetic value. Talent is also an important contributor though difficult to define for specific domains and hard to separate from expertise.

Aside from discussion of technical matters, many photographers and photography educators touch on aspects of intuition and luck (or serendipity). The challenge of describing photographic process lies in retroactively tracing short (sometimes very short) creative events. One of several goals of photography instruction is the honing of photographic intuition and visual fluency. Photographic approaches are at least in some part related to the dynamics of the photographed subject/scene. Between reactive shooting and full control in the studio there are many in-between approaches to how photographers work. All rely on fast process and slow process to different degrees. Contrast sports photography where intuition dictates when to press the shutter in reaction to the *decisive moment* with still life photography which calls on powers of reflection and questioning. Several photographers have elaborated what they mean by intuition. Some remarked that great photographs can be created through an unconscious process, ahead of their conscious ability to understand it.

Photographic work, just like other types of creative work involves solving ill-structured problems which involve sudden insights or a-ha moments. Intuition and state of mental readiness go hand in hand in this process. Intuition and insight are separate

phenomena although they are both part of creative problem solving. Intuition involves changes in tacit knowledge whereas insight is sudden awareness of a solution. Photographers prime their minds with visual material in hopes of successfully portraying an idea. This process strengthens their photographic intuition and increases the chances of arriving at insight/solution. Practice through taking many photographs is very important in developing expertise in photography and bolstering intuition. From the perspective of cognitive psychology, practice in perceptual-motor domains like photography develops procedural schema. In such domains working on problems with one's body is more important than declarative knowledge.

Communicating intent in a photograph is another important aspect of the process. A photographer may for instance choose between a conventional and an experimental approach. For example, a wedding photographer may capture formal or journalistic style photographs or a mixture of both. Photographic intent is trained through deliberate looking, framing and taking many shots. Skilled judges of photography can quickly detect intent or a lack thereof. Photographers train their ability to decide whether to react or to plan an exposure, show greater or a lesser degree of complexity and ambiguity knowing that the less ambiguous the image, the more immediate the message. In a highly ambiguous image the photographer delivers a visual punchline so to speak by, for example, making the key subject less central in the overall composition and causing the viewer to experience a *delay* in detecting it.

The limited psychological research, educational literature and photographers' accounts distill three key elements of the photographic process: space (where to stand), time (when to release the shutter) and selection of the best photos. The first two elements involve constant fine tuning between camera angle and timing. Expert photographers are keenly aware and usually able to reason whether they might or might not be able to get the desired image and if they fail to capture it, they can explain why and how they would attempt to successfully achieve it. Empirical investigations mimicking the actual creative process of taking photos have used computer photo-cropping tasks using a still image and a video to test the space, time and selection aspects of the process (Serafin, 2013); results showed that professional photographers outperformed novices on all tasks when final products were judged by another group of expert photographers. Professional photographers are also more discriminating in judging photographic quality. The same study has shown that originality was not strongly related to overall quality and future research on *creativity* ratings should specifically target final products' novelty and appropriateness to context.

Photographers main challenge is what to include and what to omit from the image frame. The frame dictates photographers' decisions. Overall, the selection skill is key to the photographic process, from the initial subject and location selection, through the selection of when/where to capture an image to the selection of best images from contact sheets (paper or digital) and final selection for publications or exhibitions (the latter task is usually shared with editors and curators).

It has been suggested that there are two kinds of photographers based on how they engage in the process: those who take photographs and those who make photographs. The former are objective visual reporters, the latter are creators who stage and direct what to put in front of the camera. This dichotomy appears in photographers' accounts and is most likely related to the degree of immediate conscious effort, picture making being more deliberate. This distinction is familiar and useful to creativity researchers. Also relevant is the concept of creative finders (conceptualists) and seekers (experimentalists). These concepts deserve further study in creative photography.

Person Factors in Creative Photography

One approach to studying the person who engages in creative photography has grown out of Robert Ziller's (1990/2000) auto-photography technique. Initiating his work in the late 1970s, Ziller referred to the "phenomenological use of photographs" but subsequently he referred to the technique as auto-photography. Basically, participants were invited to take and select photos that answer the question "who are you as you see yourself?" Engaging in this process is responding to "an invitation to creativity" that potentially displays "rich revealingness" to personality that questionnaires cannot. Ziller conducted content analyses of participants' photos using disposable cameras; in two studies he found associations with "aesthetic" orientation. Aesthetic photos were those including "art, trees, lakes, ponds or flowers." They were more often included by shy than non-shy persons and less often by delinquents than by age-matched controls. Ziller's work included numerous studies extending far beyond the realm of creativity.

Dollinger and colleagues built on this notion of revealingness by rating the richness of college student 20-photo photo essays and exploring the correlates of what they identified as the quality of individuality or "creativity applied to the self." The distinction between least and most individualistic photo essays can be best seen in the descriptions of the low and high end of the rating scale for training new raters, described thusly: Level 1: *Concrete, unimaginative or dull style, commonplace and prosaic photos, repetitive content.* Level 5: *Abstract, metaphoric with many photos having deeper meanings; imaginative; creative interpretation of the photo essay task; aesthetic or artistic sensibility shown; self-expressive; self-reflective; interesting variety of themes and photos.* Low-rated photo essays typically depicted very stereotypic lifestyles (e.g., "self as partier" or "I am my pleasures and favorite things") or looked like family albums and in that sense appeared to be almost interchangeable with one another, and thus low in individuality or richness. Intermediate-level photo essays typically included aspects of the self in various roles, thus conveying more differentiation to the self but without integration and little creative expression. Highly-rated photo essays used aesthetic qualities, metaphor, and poetry and in the process revealed greater complexity, depth, and uniqueness to the self. Viewing the latter style of photo essay evokes the same responses desired by most professional photographers and photo editors: something authentic that touches the viewer, an emotional response, sense of "common humanity" with the subject, or the individuality of the photographer (Jaeger, 2007). Thus, the most individualistic photo essays emotionally touch the viewer and draw him or her into more detailed study of the photos and words used.

In the course of this research program, over 2500 college students participated by devising auto-photographic essays that included verbal commentary, as well as completing questionnaire data on potential correlates. Participants were typically about 70% non-Psychology majors in their third or fourth years of college with about 65% being female. Using Amabile's technique, 3–5 judges reviewed all photo essays independently, yielding reliabilities of 0.86–0.94. Then averaged ratings were correlated with a variety of personality, attitudinal and values measures. Numerous studies showed that, as with creativity generally, Openness to Experience was the most consistent and usually largest personality correlate of individuality/richness. However, Openness was not the only big-five correlate; Introversion and in some cases Agreeableness and Neuroticism played a part. The many personality, demographic, attitudinal and ability correlates suggested four themes that run across the nomological network (Dollinger, 2017).

Verbal Ability. First, individuality/richness consistently correlated with an inquiring intellect including vocabulary knowledge and college admission test scores but also such correlates as trait curiosity, breadth of cognitive interests, reading interests, need for cognition, investigative vocational interests and (a negative correlate) anti-intellectualism. Using Pennebaker's Linguistic Inquiry method, individuality also correlated well with *cognitive* word use in the photo essay itself. This pattern fits with and expands the meaning of the intellectual aspect of Openness to Experience in the five-factor model.

Personality. Reflecting the aesthetic aspect of Openness, a second theme was the desire to be creative, unique and self-directed. Those who devised individualistic photo essays produced more creative drawings and other products, and reported more creative accomplishments — both in contemporaneous studies while in college and in a small seven-year (post photo essay) follow-up. In values surveys and other ways, individualists had disdain for conforming to norms. Whereas their more conventional peers tended toward conservative values, individualists were more liberal and also imagined their futures as including more culturally-diverse experiences that may promote their own creativity and help them appreciate that of others.

Alienation. A third theme was negative emotionality. Compared to their conventional peers, individualists scored lower in self-esteem and they reported greater loneliness and alienation. Although they were about as likely to be involved in romantic relationships, individualists defined their relationships less in terms of fusion or overlap with the partner, and more as separate equals. The identity development of individualists is also relevant here; they tended not to follow the guidance of family or peers, nor did they emphasize social or collective identities. This is evident too within their photo essays: individualists showed fewer social connections (e.g., people touching) and made fewer references to friends. Individuality also correlated at times with negative or abusive life experiences, and with greater expectations of distressing or physically threatening events in their futures. Devaluing *recognition*, individualists were not particularly self-promoting, and in the follow-up study, they devalued the importance of relationships with work supervisors. However, they were not necessarily narcissistic (near-zero correlation) and didn't typically desire individuation in the sense of recognition and standing out from the crowd. All in all, this pattern of correlates showed that individualists could be alienated but strived to find their own life paths.

Wisdom. In accord with several developmental psychological conceptualizations, the correlates of individuality suggest interiority and maturity. Across different studies, individuality/richness ratings correlated with age, ego development, and with mature values. In terms of individual rather than composite values, individuality correlated with a contemporaneous valuing of *wisdom* and the tendency to devalue extrinsic rewards at work seven years after doing the photo essay. Within their photo essays, individualists' word use reflected insight and tentativeness plus metaphysical themes like death and dying (but not leisure interests), also suggesting "interiority" and wisdom. Rich photo essays were created by those who rejected superficial identity concepts as self-defining and those who focused on inner aspects like their dreams or imagination. Individualists were more likely to have experienced personal therapy, presented more vivid dreams, and were more psychologically minded. Their reading interests were more intellectual as opposed to focusing on romance, sexuality, and sports. In general, individualistic young adults had a more serious approach to their current lifestyle, reflected in their greater investment of time in study and their lower likelihood of depicting alcohol within photo essays. Taken together, this set of correlates suggests wisdom, maturity and inner-direction in participants who devised richer photo essays. In short, the four sets of correlates showed that richer individualistic photo essays were associated with verbal ability, an openness to inner, and aesthetic worlds, an inclination to march interpersonally to "a different drummer" and a wisdom and seriousness of purpose directed toward the meaning of their lives.

Photograph as Creative Product

Generally, photographs are defined as pictures formed by light falling on photosensitive surfaces and then stored on paper or digital media. Although photographs belong to the domain of visual media, creative photographs specifically exist within visual arts as evidenced by presence of photography in some of the influential current art publications (*Art News*, *Aesthetics*, *Apollo* and *Art Review*). Photographs serve aesthetic and practical purposes and have become ubiquitous as a mode of communication in modern life. Technological advancements in photography (e.g., shorter exposure times, inventions of color and digital photography and post-production) have been utilized in advertising, news and more recently social media.

It is hard to separate the aesthetic from practical purposes of photography especially when considering the aesthetic value of photographs made for purely practical reasons and with minimal human directed creative effort (e.g., Hubble telescope images of space, diagnostic imaging of brain matter, or microscopic images of cells, all of which blur the boundary between the practicality of science and the aestheticism of art). Similarly, the distinction between fine art and commercial photographs is sometimes not

evident. One way to distinguish between the two categories is in the timing of when the need or value of photographs is established. Commercial photographs result from assignments by external agencies (magazine editors, art directors) where the value is established ahead of time. Fine art photographs, on the other hand, are created first and their value is later evaluated. Commercial photographs are also often presented as series of best and lesser quality images to preserve flow and story whereas fine art photographs displayed in galleries are usually a smaller set of images, all superior quality.

The perceived value of photographs is a result of challenges presented to viewers. Successful solutions to visual problems result in pleasant viewing experiences. Viewers' experiences of art can be seen as a "mirror" model of art making and art perception. In this model, early stages of art viewing correspond to the final stages of art making and later stages of viewing correspond to earlier stages of art making, with added layers of emotional valence, ambiguity, social context. Successful visual art takes the viewer from the initial automatic interest in technical excellence, through intermediate memory-based processing of style, typicality, content to final meaning-making achieving a deeper understanding of the work's cognitive and emotive qualities (Tinio, 2013). Similarly, successful creative photographs engage viewers to go deeper beyond the technical excellence. Consider the number of choices photographers have when capturing a photo: conventional vs. unconventional angle, spontaneous vs. planned, documentary vs. expressive, simple vs. complex, clear vs. ambiguous, and still vs. dynamic (Freeman, 2007). This complexity in process seems to mirror the complexity (and creative value) of photographic images.

Psychological research on aesthetics supports ideas by photography educators and graphic design scholars. Photographs as creative products possess levels of *visual power* which refer to their *arousal potential* or their capacity to induce stimulation. Arousal potential can result from intensity, novelty or depth of meaning of photographs. More specifically in photography, visual power is related to format, pleasantness, expressiveness, viewers' familiarity with content, complexity and content type, sharpness, contrast and grain as aspects of technical quality, and challenges to visual processing introduced by photographers (i.e., via framing, cropping, peak-shift effect, and other techniques). The need for visual power varies with the characteristics of audiences such that highly homogeneous audiences need higher visual power.

Indeed different types of viewers judge the same images differently. Expert photographers, for instance, have a more varied set of aesthetic judgment criteria than non-experts and therefore are better at detecting complexities present in high creativity photographs (Serafin, 2013). Expressive and uncertain photographs appeal to expert photographers whereas familiar and pleasant photographs appeal to non-experts. More research is needed on levels of visual power and complexity of photographs, from physical, through visual grammar/design to deep cognitive, emotional and social meanings.

Photographs are most like the products in creativity research when they are evaluated in juried competitions. Elsewhere, Serafin and Dolinger (2017) compared the published views of five judges of professional photographic competitions. While varying widely in the number of elements considered, the comments translated to three basic judgment dimensions: (1) creativity; (2) photographic technical quality, and (3) genuineness or authenticity of content. While creativity is judged separately from technical aspects, it is rare for photographers to define what they mean by creativity, using an implicit assumption of "knowing it when I see it." Although most juried competitions do not intentionally use Amabile's Consensual Assessment Technique, they do share this common assumption.

Press/Environment in Photography

Any consideration of environmental press in photography necessarily recognizes the outer-world focus of this art. Arnheim described photography as a less controlled and thus a less creative process since it is dictated by the environment (an 'outside-in' approach) as opposed to control through medium and an artist's labor (an 'inside-out' approach).

At the onset, art critics were ambivalent toward photography. They recognized its value in preserving subjective experience yet they often expressed anxiety over what they perceived to be its destructive power. The concept of *disruptive technology* (a technology that disrupts and often replaces older technology reshaping the domain) was not introduced until much later and people of the time were not yet exposed to the fast-paced changes in technology and innovation that we experience today. Photography signified modernism and anxiety. Anxiety and changes in technology are true of photography to this day and undeniably contribute to the pressures experienced by photographers.

Artistic photography, like painting, has been used to produce works that evoke aesthetic experiences in a wide audience. Like painters too, photographers have congregated, created styles, and formed groups as part of *creative ecosystems*. One example is The Camera Club of New York founded by Alfred Stieglitz in 1884. Photojournalism became a domain and with it, the first photographic agencies were formed. These organizations reflect the sociocultural aspect of photography where expert and nonexpert audiences accept or validate photographs as creative. This sociocultural validation marks the final stage in creative production.

Photography today encompasses several sub-domains. As an example, educational offerings at the School of Photography at the Academy of Art University in San Francisco include commercial, documentary, fashion, fine art, still life photography and photo illustration. These map onto their respective career opportunities. Photography is an extremely competitive field where talent needs to be honed through supportive and challenging training environments. Budding photographers need tools to create cohesive bodies of professional work representative of their individual styles. The breadth of sub-domains in photography influences training. Street photography techniques are different from fine art photography tools and concepts. The

quality of photographs increases when one compares photojournalism or street photography to fine art photography. However, the general process is basically the same: “enthusiasm for subject, careful planning, working situation through many images” (Hurn and Jay, 2008, p.39). The difference in quality may come as a result of the selection process; journalistic photography is utilitarian and needs to fit with the immediate goals of the project whereas in fine art photography the final choices are up to the artist.

Today’s photographers experience pressures that did not exist 20 or even 10 years ago. These include *data smog* or the overwhelming quantity of visual digital data, an associated shortage of gatekeepers (editors, reviewers, curators) and the very heady possibility for one’s photos “to go viral.”

The cost of professional photographic equipment may be prohibitive to some and thus limit the sample of photographic talent to wealthier societies and individuals who can make the hefty initial investment despite the competitive and unsteady professional future. In addition, with heavy photo gear there often is a higher than average risk of injury in some subdomains which may partly explain why, at least in photojournalism, there are more male than female photographers. For those who secure careers in photography, the stress on utilitarian aspects may stifle their creative freedom and expression. In addition, they may need to supplement their income through unrelated work. Practicing photographers also mention the solitary nature of their work; they often wait for decisive moments and fast bursts of activity rather than work in a linear, logical fashion which may be more conducive to social activities. Especially nowadays, photographers express anxiety over being replaced with hordes of amateur photographers equipped with camera phones. To cope with the pressure, many photographers diversify their skill sets by adding video production skills.

What is next? Some predict that the optics in photography are as good as they can get and the future of photography is computational as in writing code. Others mention artificial intelligence, phasing out of some technologies, constant connectivity and virtual reality. Photographers will have to continue to adapt to more and more rapid photo technology revolutions. In addition, they need to continue to keep in mind ethical issues in photography, particularly relevant in photojournalism, and the value of balance between creativity and authenticity. Photographers might also consider that the monetary value of art photographs is influenced by artists’ reputation, quality and timing of printing, size of the series, and size of the edition.

Concluding Comments

Creative photography emerged to express a subjective need for visual communication. Creative behavior has evolved across various cultures suggesting its important survival value for society. There exists a range of creative photographic products; some are universally acknowledged as high in artistic value and some possess a more locally appreciated creative value. Compare Dorothea Lange’s portrait of a migrant mother with countless other family photographs of mothers or Ansel Adams’ Yosemite photographs with many others snapped by tourists. Perhaps, the former resulted from *eminent* creativity (genius) and the latter from everyday creativity. The best artistic photographers, who possess the requisite talent and expertise, are able to distill reality into a set of universal visual ideas and therefore more likely exhibit eminent creativity. Lange’s *Migrant Mother* communicates “this could be any mother, your mother or this could be you.” The best art photographs communicate timeless ideas whereas family albums and photographs on social media preserve personal memories.

There exists a tension between creativity and authenticity/objectivity in photography. Is creativity in photography desirable or even ethical? In some settings creativity is appropriate (photographs as aesthetic objects) whereas in others it may be less important than authenticity (photojournalistic images). In reality, even though aesthetic and creative function may not be used to override authenticity in photojournalism, time and time again photographers manipulate their work to achieve higher visual and emotional impact. Thus, it seems creative photographers will not be replaced by drones so long as we need a human mind to process which image will best communicate an idea. In closing, the impact of photography for human functioning was beautifully articulated by Sarah Laurent in a 2017 National Geographic piece:

In a deeply personal way I feel an image is a poem about time, about “staying the moment.” Photography can defeat time. Images can keep the memory of a loved one alive, hold a moment in history for future generations, be a witness to tragedy or joy. They can also change behavior, stimulate understanding and create a sense of urgency that will move people to action. Photography is the universal language that speaks to the heart.

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Physics

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Glossary

Convenience Sample A group of individuals who receive creativity tests or are otherwise involved in research even though they have not demonstrated any unambiguous creativity. They are, however, easy to find and thus a convenient sample with which to do research.

Crystallizing Experiences Some specific event occurring during childhood that creates and lifelong interest.

Elegance A simple and yet powerful idea or equation, such as $e = mc^2$

Evocative Experience Individuals often learn from experience, and they are sometimes recipients of what experiences are imposed on them, but other times individuals may have an impact on conditions which in turn create particular experiences. Creative individuals thus may both receive but also evoke particular experiences.

External Validity Generalizability of results, typically only provided by research conducted in a naturalistic setting and lacking in research conducted within a laboratory or controlled setting.

Gedanken Experiment A highly visual method where certain ideas can be tested. Apparently Albert Einstein frequently used this method for the exploration of possibilities.

Hyperspace An idea used in physics, as well as mathematics, that has recently been utilized in creative studies. The creative process may involve searching for ideas by looking in varied dimensions, and the number of dimensions may be infinite.

Internal Validity Experimental control, such as that provided by research conducted within a laboratory.

Intrinsic Motivation Drive that comes from within the individual and is often related to creative effort. It is in contrast to extrinsic motivation which is a response to incentives, rewards, bonuses, and the like—things outside of the individual.

Presymbolic Thinking Reasoning that occurs before symbols are assigned to thought so there is less or at least untraditional logic and great latitude.

Unambiguous Creativity The creativity that is manifested by famous people who have done something to change the way humanity views the world. They offer something original and effective, and what they offer is original compared to world wide standards and effective for large numbers of individuals. **Paradigm Shifts** Dramatic changes that follow from the gradual progress of normal science. Assumptions are questioned when there is a paradigm shift.

Introduction

The field of physics and those working within this field have received special attention in creative studies. There are a number of reasons for this. First, there are a number of interesting connections between the field of physics and creativity. Most obvious may be the creativity that leads to breakthroughs and progress in physics. Such progress may take the form of a *paradigm shift*, which occurs when assumptions which have endured for some period of time are suddenly rejected, the result being a radical change in how humanity, or at least scientists, view the world. A number of paradigm shifts have been described in various biographical reports and case studies of famous creators, which in turn have led to particular contributions to our understanding of creativity. These reports and case studies often point to the personalities of creative physicists and provide good examples of how the creative process is used. There are also messages about the impact of setting and context on creative work within physics. Another connection between physics and creativity represents this same *direction of effect*, with physics influencing our understanding of creativity. Consider, for example, the metaphors and models (e.g., hyperspace) which are used in physics but can frequently be applied to creativity studies as well. Then there is the worldview that is suggested by the field of physics—or more accurately, the various world-views—for physics tells us much about what is possible and what is beyond the direct experience of individuals. Not surprisingly, philosophies often follow from physics, and these philosophies in turn direct and constrain how human creativity can and should be used. Each of these connections is explored in this article.

Creative Physicists

Creative studies often look to and benefit from case studies of unambiguously creative people. One advantage of this kind of research is that the creativity displayed by the individuals studied is unambiguous. In other research creativity is difficult to define, or at least has a definition that has been debated for decades, and the debate is understandable when the creativity is ambiguous, as is the case when a convenience sample is involved in experimental research and when participants in this research (e.g., college sophomores, or these days, users taking tests on SurveyMonkey or the like) receive so-called tests of creativity under controlled conditions. In fact there are several reasons to doubt that tested creativity is authentic. The first is implied by the idea of a convenience sample: the participants may not be motivated to express their creativity; and if we assume that there is a continuum with highly creative individuals at one extreme and not as creative individuals at the other extreme, the participants could be less than outstandingly creative. Then there is the possibility that the experimental conditions impose constraints, which may inhibit creative expression. The research participants may behave in accordance with expectations, which makes original self-expression difficult. And highly controlled settings allow internal validity (a label for control) but are notoriously low in external validity, meaning that results would not apply outside of the experimental setting. This sort of thing is especially relevant to creativity because creativity is thought to involve spontaneity, intrinsic motivation, and autonomy, and such things may be precluded by experimental control. When unambiguously creative individuals are studied, on the other hand (see Howard Gardner's work on Gandhi, Freud, Stravinsky, Einstein, Martha Graham, for example, or Howard Gruber on Jean Piaget and Charles Darwin), the creators are not placed in any experimental situation. Instead they are living their lives, and those requirements of creativity just listed (e.g., intrinsic motivation) are not inhibited. In addition, they are famous because they have offered something to society that is highly original and effective. They have in fact changed the way the world is viewed. Their creativity is beyond question. It is unambiguous.

At the same time there are limitations to case studies. They usually look back at what has happened in the past, so generalizations to the future are questionable. Things may have changed—certainly they have changed! Thus the conditions experienced by those unambiguously creative adults, in the past, may not characterize anyone today. Along the same lives, the individuals under study may live idiosyncratic lives, so again, the findings may not generalize broadly. Then there is the fact that no experimental control is imposed, so cause-and-effect is not entirely certain. Consider here the theory of evocative development, where a child has an impact on family life and thus is not a mere recipient. He or she evokes experiences. This may again apply especially to highly creative children whose talents may be noticed by the parents and others and, as a result, changes are made to support the creativity. When this happens a child is not merely responding to experience but instead is also creating conditions which in turn lead to experience. Still, at the very least case studies offer hypotheses that can be tested later with controlled research. This can lead to respectable scientific theories of creativity which are both consistent with experimental research but also consistent with unambiguously creative cases.

The best-known case may be that of Albert Einstein. He changed the world and did so with some unique methods. These tell us something about how certain people use certain processes. Einstein used *Gedanken* experiments, for example, which are highly visual explorations of possibilities in physics. He supposedly imagined what would occur if two people passed each other while riding in trains moving in opposite directions, or what it would be like to ride on something moving at the speed of light. This gave him insights about relativity (e.g., riding on a beam of light would make everything else appear to slow and perhaps even stop). Interestingly, his ideas were elegantly mathematical (e.g., $E = mc^2$) and entirely theoretical, but decades later supported by experimental observations. Light has been observed to change as it passes close by a body that has powerful gravitational pull, just to name one example.

Howard Gardner's study of Einstein's childhood uncovered the importance of *crystallizing experiences*. In Einstein's case this occurred when he was a young boy and he was given a gift of a compass. Apparently he was fascinated by the fact that the compass could find the magnetic north pole, no strings attached, as if by magic. Note here an early fascination with magnetic waves, which can easily be associated with many of his adult *Gedanken* experiments about electromagnetism. Studies of Einstein's brain have also been reported, though here great caution is warranted. Assaying suggested that his brain may have had an abnormal amount of glial cells in the visual cortex, but his brain was not examined carefully until years after his death and the chain of evidence (i.e., the maintenance of the sample of his cortex) may not have been carefully controlled and monitored.

Tweeney (1996) examined a variety of physicists but focused primarily on Michael Faraday. The reason for this focus: Faraday kept a daily diary so Tweeney was able to explore thinking as it developed and changed. One very important idea to arise from Tweeney's research was that much occurs *presymbolically*. This can be contrasted with what he called the "traditional view." In his words, "In the traditional view, to understand thinking is to understand the process by which symbols are rearranged, modified, used, and so on" (p. 168). Tweeney much preferred an approach that he said was more consistent with what "William James (1890) referred to as a 'reinstatement of the vague to its proper place in the mental life'" (p. 254). Presymbolic processes occur before symbols are formed and do not follow the logic which is easily described. This is what makes them vague. Presymbolic processes may appear to follow no logic at all, though it is possible that there is a logic but it cannot be understood if the observer takes an objective perspective and relies on traditional logic.

This view is consistent with Miller's (1996) research on scientific creativity. Miller mostly wrote broadly about scientific creativity rather than physics, but some of his ideas are based on his examination specifically of electromagnetism and "atomic theory" (p. 113). One particularly interesting volume is Miller's (2008) *Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc*. As that title suggests it examines Picasso and Einstein, an artist and a physicist—who never met. Yet they worked within the same era and are often attributed with introducing modernity. Was there some commonality, *Zeitgeist* perhaps, that influenced them both? Both

were influenced by Poincaré and his theory that there is a dimension beyond the ones typically perceived and acknowledged. For Miller, Picasso captured this new dimension in art, while Einstein wrote about it. Miller even claims that Picasso and Einstein were working on the same problem: “how to represent space and time at just the moment in history when it became apparent that these entities are not what we intuitively perceive them to be.” One important suggestion from Miller is that physics can be influenced by historical context—and by aesthetics. Recall here the idea of elegance, mentioned briefly above.

Miller (2009) took a somewhat similar approach in his volume *137: Jung, Pauli, and the Pursuit of a Scientific Obsession*. Pauli, recipient of the Nobel Prize in 1945, wrote about relativity but was probably best known for his *exclusion principle*. He also may have been first to recognize the existence of a particle that has no mass nor charge, namely the neutrino. He had a huge impact on the nascent field of quantum physics as well. He was, sadly, often unhappy, which took him to Carl Jung, student of Sigmund Freud and famous psychoanalyst. Jung is very well known, in part for his thinking about *archetypes*. So here again Miller examined a physicist but within a social context. And Jung and Pauli certainly had breadth in their thinking! Both felt that certain numbers have important qualities and represent critical processes in the universe. Hence the “137” in the title of Miller’s volume. 137 does represent an atomic constant, but a number of people, including Pauli and Jung, felt it plays a much larger role. One conclusion from Miller’s examination is that creative people, including certain physicists, benefit from open mindedness. They may even seriously consider ideas and concepts that strike the rest of us as questionable. Yet this open mindedness may in fact play a role in creative work.

Like Miller (2008), Leonard Shlain (1991) explored how physics is related to art. Shlain did note the differences between art and physics, but after analyzing various theories, including Einstein’s, and various artists, including Cézanne and Monet, Shlain offered the controversial theory that artists are aware of things before physicists. In fact, for Shlain, artists use ideas in their art which are later “discovered” by physicists. Sometimes artists beat physicists by 20 years, as was the case with the art of Cézanne and Monet who both painted as if they knew about the paradigm shift that would only much later be initiated by Einstein. Shlain offered other examples of this foreshadowing, including Jasper Johns and Andy Warhol. Apparently, physicists like Pauli are open minded, but not quite as open-minded as artists.

Physics Changing Theories of Creativity

Physicists often use metaphors in their work. Researchers studying creativity sometimes do the same thing—and sometimes the root of those metaphors can be found in physics. There are theories that describe the creative process using chaos and fractals, for example, as well as a fairly recent theory that describes creative thinking as an exploration of *cognitive hyperspace*. Some background must be given before this idea is defined.

That background involves the theory of divergent thinking, which is covered in another entry of this same volume, and often used in the creativity research. Indeed, tests of divergent thinking are probably the most commonly used assessment in this field. The idea of divergent thinking goes back to J. P. Guilford. He built a large Structure of Intellect model in the 1950s and 1960s. It included 180 different “cells” and types of thinking. This large theory was discredited, but mostly because Guilford used a subjective method in his (factor analytic) statistics. Still, the distinction between divergent and convergent thinking has proven to be enormously useful in creative studies and related fields. For Guilford, thinking which takes different pieces of information and moves toward one correct or conventional cognitive results (e.g., a solution or idea) requires convergent thinking. Thinking which instead leads to a number of varied solutions and ideas requires divergent thinking. This really is itself a pair of metaphors. Just as roads or waterways may converge or divergent, so too may thinking, though in actuality there is probably no physical meeting or separation, as there is in the case of roads or rivers.

As a matter of fact Acar and Runco (2017) pointed to exactly this fact, that there is no actual divergence in tests of creative potential which purportedly assess divergent thinking. Acar and Runco described how a person can have a high score on a test of divergent thinking even though their cognition may not actually diverge. They cited associative theories where ideas are concatenated, one after another, and where an original idea is remote (quite removed from the original problem) and not divergent but actually just far removed in a straight, linear fashion. There is quite a bit of evidence for this: remote associates are often found when a person is given adequate time so their thinking may move from one idea to the next.

Acar and Runco thus proposed an alternative theory and method for testing, or at least for scoring tests. They referred to cognitive hyperspace, the idea being that creative people may have an idea (or solution), and then another idea. They may follow one path or direction of thought in a linear fashion. But their open-mindedness and creative potential allows them to redirect their thinking. The cognitive pathway might make a dramatic turn. This can be seen as a turn to a perpendicular path. Ideas along this path will appear to be quite different from the original ideas. Then the person may make another turn in their thinking and explore another perpendicular path. If this person was following actual pathways, perhaps talking a walk, they would be limited. They could only turn in a perpendicular manner very few times. If they could fly, that would add a perpendicular, but still he or she would be limited. But thinking is not limited in this fashion. Thinking can take one dramatic turn after another. Creative cognition can go into hyperspace, which is a concept used occasionally by physicist and mathematicians. For Acar and Runco, this may very well be a good method for finding highly creative ideas. They offered some very tentative support for the benefits of exploring cognitive hyperspace. What is more relevant, for the present purposes, is that this exemplifies how creativity research may draw from physics. As mentioned briefly above, other concepts used in physics (e.g., chaos and fractals) have also been used, albeit in limited ways, in the creativity research.

Conclusions

Paradigm shifts in physics require creativity on the part of the physicist. In fact, it may be that more incremental steps also require creativity. No wonder there are quite a few case studies of physicists, even in journals devoted to creativity, such as the *Creativity Research Journal* (Miller, 2008; Tweney, 1996). In addition to the examples described in this entry, Raina (2003) wrote about Erwin Schrodinger and Gooding (1996) about Michael Faraday. Recall that the information obtained from case studies may best be used to formulate hypotheses for later experimental study. It may not generalize. Still, case studies are fascinating and often consistent with other theories of creativity.

If this entry was longer it would certainly be worthwhile to discuss Erwin Schrodinger. That is because he used a method much like Einstein's Gedanken experiments, and in fact his most famous idea was an extension of something first considered by Einstein. Schrodinger really extended the original idea and the experiments known as *Schrodinger's Cat*. Physicists see this as a critique of the *Copenhagen Interpretation of Quantum Mechanics*, but for most of us it merely demonstrates the role of paradox in quantum physics. Simplifying, a cat is in a sealed box, and is poisoned, but since direct observation is impossible, a quantum view is that at some point the cat is both dead and alive.

This is especially relevant to recent creative studies because, more and more, the role of paradox in creative thinking is being recognized. Albert Rothenberg is well known for his work (also summarized in the *Creativity Research Journal*) on Janusian Thinking, and it involves paradox. Janus was the Roman god of doorways and could see both in and out at the same time. Rothenberg offers a number of examples of how creative breakthroughs—including the idea of *complementarity*, where particles simultaneously display characteristics of waves and quanta—are well explained by describing how the creator used Janusian thinking and what from an ordinary perspective appears to be paradox. Many others have used paradox in recent theories of creativity (Runco, 2016, 2019), including Ronald Beghetto (2018), who applied the idea to efforts to support creativity in educational settings.

The present chapter offers several case studies, which should be followed up with good experimental research. It also points to metaphor, visual imagery, openness to wide alternatives, cognitive hyperspace, presymbolic processes, and paradox as possible methods used for creative work in the field of physics. More research is needed to determine which of these, if any, is in fact idiosyncratic and only useful in physics or perhaps useful more generally in other sciences as well.

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Play[☆]

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Pretend Play

Play is a universal phenomenon of childhood. Play comes in many forms, but the form of play most relevant to the area of play and creativity is pretend play. Pretend play involves the use of fantasy and make-believe and the use of symbolism. Pretend play also involves affect and expression of emotions. [Greta Fein \(1987\)](#) conceptualized pretend play as symbolic behavior where one thing is treated as if it were something else; a Lego becomes a milk bottle or a block becomes a telephone. Fein also stressed that pretend play is charged with feelings, so that affect is intertwined with pretend play. She viewed pretend play as a natural form of creativity.

Much of what has been written about the development of creativity in children has focused on the development of play. [Keith Sawyer \(1997\)](#) conceptualized pretend play in young children as improvisational in that it is unscripted but also has loose outlines to be followed. Much of creative performance involves improvisation.

[Lev Vygotsky](#) theorized that imagination developed out of children's play. He stated: "The child's play activity is not simply a recollection of past experience but a creative reworking that combines impressions and constructs from them new realities addressing the needs of the child" (1930/1967, p.7). Through play, children develop combinatory imagination-the ability to combine elements of experience into new situations and behaviors. Combinatory imagination is important in both artistic and scientific creativity.

Play follows a developmental process. Before 2 years of age, children play with objects similarly no matter what their actual functions are. Around 2 years of age, children discover that objects have specific functions. They recognize that a telephone is used to talk to someone and a plate is used to hold food. Also around the age of two, children begin to discover pretend play. They are able to pretend that a circular block is a wheel. Children continue to develop pretend play abilities throughout their childhood-until about 10 years of age. There are individual differences in how frequently children engage in pretend play and over what period of time during their childhood. In pretend play, children are able to think symbolically and not be confined to a single use of an object. The child is able to transform the object to represent many things but is also aware of the primary use of the object.

As children develop, their play becomes more complex. Jeffery Dansky, in his [1999](#) review, pointed out that in high level play, children display all seven dimensions of original thinking described by Roberta Milgram: associative fluency, imagery, curiosity, fantasy, problem finding; metaphoric production; and selective attention deployment. He concluded that individual differences in play have implications for individual differences in creativity. Dansky also theorized that adopting the "as if" frame in play may open the door to a mode of problem solving where one can play with ideas and possibilities, which is so important in creativity.

Fein studied the pretend play of 15 preschool children who were master players. From her observations, she concluded that good pretend play consisted of five characteristics:

1. Referential freedom. The "as if" quality in play where one object is treated as if it were another, one person functions as if they were another, and time and place is as if they were different.
2. Denotative license. Pretend events occur and there is a divergent stance with respect to actual experience.

[☆] *Change History:* November 2019. Sandra Russ updated the text throughout the article.

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3. Affective relations. Symbolic units represent affective relationships such as fear of, love of, or anger at. Information about affective events are stored and manipulated in ways that make affective sense for the player.
4. Sequential uncertainty. There is a nonlinear quality to the sequence of events.
5. Self-mirroring. The self is observed through a distance. Children are aware of the pretend quality.

Play and Creativity

In 1983, Nathan Kogan stated that the research on the play and creativity link was the most promising set of findings in the children's creativity literature in the previous decade. The promise of that early research has continued to be realized.

It makes theoretical sense that pretend play would relate to creativity because many of the processes involved in the creative act occur in pretend play. In order to study play and creativity, one must be specific about the underlying processes involved.

Sandra Russ in 2004 reviewed the literature and developed a model of cognitive and affective processes that occur in both play and creativity. Through pretend play, children practice cognitive processes such as divergent thinking, organizing thoughts into a narrative, flexible thinking, and the use of symbolism and fantasy. Pretend play also is a medium for affective processes to be expressed. Children use play to express emotions and affect-laden fantasy, to regulate emotion, and to experience the joy of the play experience itself. Interpersonal processes can also be observed in pretend play. Characters communicate and interact with one another and role play different characters who have different perspectives about events.

Pretend Play and Creative Cognitive Processes

Dorothy and Jerome Singer in many of their writings suggested that areas of cognitive development are facilitated by pretend play abilities. Play helps the child to expand vocabulary and link objects with actions. For example, a child can learn words and actions by labeling objects and their functions through play—"I drink from a cup" or "I go in a car." Play also helps the child develop object constancy and form event schemas and scripts. For example, a peek-a-boo is very exciting for a young child who learns that even though mother is hiding, she will return. Pretending to play house or doctor is another way children learn about their world. Pretend play also helps children learn strategies for problem solving, develop divergent thinking ability, and develop a flexibility in shifting between different types of thought (narrative and logical). Singer and Singer thought that the last two categories were especially important in creative thinking.

Cognitive processes that are thought to be important in creative thinking are divergent thinking, transformation abilities, and insight. Divergent thinking is the ability to generate a variety of ideas. J. P. Guilford identified divergent thinking as important in and unique to creative problem solving. A typical item on a divergent thinking test would be "How many uses for a newspaper can you think of?" Divergent thinking involves free association, broad scanning ability, and fluidity of thinking.

Guilford also proposed that transformation abilities were involved in creative thinking. Transformation abilities involve a flexibility of thought that enables breaking out of an old problem solving set and seeing a new way to solve a problem.

Insight into the solution of a problem is important in creativity. Early research on play and creative problem solving investigated play and insight ability. Studies found that play in children 3–5 years of age facilitated insight into a problem solving task. Brian Vandenberg concluded that all the studies had the consistent finding that play facilitated insightful tool use and enhanced motivational activity. Variables of task type and difficulty and age were mediating factors. He discussed the similarity between play and creativity in that both involve creating novelty and disregarding the familiar.

Much of the creativity and play research has focused on divergent thinking. Jerome Singer and Dorothy Singer (1990) thought of play as practice with divergent thinking, so there should be a strong relationship between play and measures of divergent thinking ability. Many researchers found significant relationships between play and divergent thinking, usually independent of intelligence. For example, Russ and her colleagues found consistent relationships between fantasy in play and divergent thinking in preschool children as well as elementary school children. She reviewed this research in 2014. In one longitudinal study, play in first and second grade children was associated with divergent thinking ability when they were in the fifth and sixth grades. Children who could use fantasy and imagination on a pretend play puppet task could generate more uses for objects (fluency) on a divergent thinking task four years later. The relationship between pretend play and divergent thinking remained stable over time.

Much of the research in this area has been correlational in nature, but there are some well-carried out experimental studies that have found that play facilitates divergent thinking. Dansky found, in several studies, that play enhanced divergent thinking in pre-school children. In one of his studies, he found that free play facilitated divergent thinking, but only for children who engaged in make-believe. It was the pretend element that was important. Some critics of this research have raised the issue of unconscious experimenter bias because the same experimenter gave the play and divergent thinking tasks. Peter Smith and Sue Whitney, in a carefully executed study, failed to confirm the hypothesis that play would enhance divergent thinking in pre-school children. However, it is also possible that introducing a new examiner between the play and the divergent thinking task broke the set that was being induced by the play. Thus, there would be no experimental effect of play on problem solving. Another important point is that there have been a number of correlational studies that did use different examiners for the play and divergent thinking tasks and did find significant relationships between the variables.

Although there is much evidence suggesting that similar processes are involved in play and divergent thinking, it is worthwhile to speculate on the actual cognitive processes that account for the link. Dansky's theoretical explanation was that the process of free combination of objects and ideas involved in play is similar to the elements involved in creative thinking. He thought that the free symbolic transformations inherent in pretend play created a temporary cognitive set toward a loosening of old associations. Others stressed the role of play in the development of flexibility in problem solving. Play provides the opportunity to explore new combinations of ideas and to develop new associations for old objects. The capacity to see old objects and ideas in new ways should aid in developing transformation abilities; that is, the ability to break out of an old set and see a new solution to a problem. Also, children's play behavior involves a search for alternate modes of relating to the object, a process similar to searching for alternate uses for objects in divergent thinking tasks. Anthony Pelligrini conceptualized that in play children recombine behaviors and develop flexible strategies. His research with rough and tumble play supports that concept.

In summary, much of the explanations about why play relates to creativity, and especially divergent thinking, have focused on cognitive variables such as cognitive flexibility, loosening of old cognitive sets, practice with associations, recombination of old objects and ideas and symbolic transformations.

Pretend Play and Creative Affective Processes

Pretend play is infused with affect for many children. Children use play to process emotions. J. Singer has discussed how play helps children organize their emotional experience. Affective processes also play a role in creative thinking.

Fein, Russ, and J. and D. Singer are all theorists who have stressed the importance of affect in play in the link to creativity. Fein proposed an affect symbol system that gets activated in pretend play and is important in creativity. An affective symbol stores information about emotional events and is manipulated and worked with in pretend play. Russ, from a psychodynamic framework, stressed the importance of pretend play in helping children to access emotional memories, fantasies and associations. Children who are comfortable letting their thoughts roam a broad spectrum of associations and memories that are affect-laden should be more creative. Singer and Singer thought that a cognitive-affective framework was central to exploring imaginative play.

Just as it is important in creativity to play with ideas and images, it is also important to play with affective content. Affect expression in play occurs from a very young age. Interestingly, when affect expression in the play narrative in children from 6–10 years of age was compared, there was no developmental differences found in the amount of affect expression over these years. In terms of stability of affect expression, Russ, Robins, and Christiano found significant relations between affect expression in children in play when they were first and second graders, and affect expression in play narratives when they were sixth and seventh graders. This finding suggests some stability in the tendency to express emotion and emotional themes in narratives across time.

Fein viewed affect as being intertwined with pretend play. She viewed pretend play as symbolic behavior organized around emotional and motivational issues. The proposed affective symbol system represented affective relationships which the child manipulated and elaborated in play. This system could be activated by pretend play or drawing and is important for creative thinking.

Russ, after reviewing the literature, proposed categories of affect that are important to creativity and also occur in play. These include:

1. Access to affect-laden thoughts and ideas. This is the ability to think about emotional content. Affective symbols would be in this category as would primary process thinking, a key psychoanalytic concept.
2. Openness to affect states and feelings. Experiencing the emotion is also important to creativity and children use play to express positive and negative emotions.
3. Affective pleasure in challenge and problem solving. This is the ability to experience pleasure and joy in play and to "get lost" in the play experience.
4. Cognitive integration, emotion regulation and modulation of affect. This blend of affect and cognition that is important in creative thinking and occurs in play. Emotion is in the context of a narrative.

Russ in 1987 developed the Affect in Play Scale (APS) to meet the need for a standardized measure of affect in pretend play. Until then, measures focused only on cognitive aspects of play. The APS uses puppets and blocks with standardized instructions in individual 5 min play sessions. The play is videotaped and coded for amount of affect expression in the play. Frequency and variety of affect themes is scored with a frequency count. Enjoyment and comfort in playing is rated on a five point Likert scale, as is imagination and quality of the fantasy narrative. There is also a pre-school version of the scale that uses a variety of toys with more structured instructions. Also developed was a brief rating version that rates the child's play in vivo and does not require videotaping.

Research using the APS with a variety of child populations and researchers has found significant relationships between affect in play and creativity. In general, children who express more affect themes in the play narrative are more creative. Affect expression in play has related to fluency and originality in divergent thinking, to teachers' ratings of fantasy ability, to creativity in stories, and to emotion in memory narratives. In most samples, these relationships were independent of verbal intelligence.

It is important to note that both positive and negative affect in pretend play relates to creativity. Happy themes like having fun and aggressive themes of wrestling or bickering are examples of positive and negative themes in play. Because play is pretend, there may be positive affect accompanying even the negative affect themes. Or the negative affect themes may be modulated in intensity by the child so that they are not too negative.

There is some evidence that the expression of affect in fantasy is cross-situational. Affect in play has related to expression of affect in memory descriptions and expression of affect themes on the Rorschach. The relation to affect themes in memory descriptions could have implications for creative writing. Children who develop the ability to think about emotion-laden memories and express affect in narratives would have an advantage in areas of creative writing where emotions and understanding the emotions of others is important.

Playfulness and Creativity

Playfulness is another general characteristic of play that is important in creativity.

It is generally accepted that a playful individual has an internal predisposition to interact within their environment in a playful way regardless of their exposure to tasks, contexts, or materials that may yield behaviors that are related to play. Lynn Barnett defined playful individuals as those who naturally possess the ability to frame or reframe their experiences in a way to provide oneself with "amusement, humor, and/or entertainment."

A pioneer in the research of playfulness, Nina Lieberman attempted to distinguish differences between play behaviors and playfulness as a trait in children. From her research she was able to delineate five components to describe this playfulness quality: physical spontaneity, cognitive spontaneity, social spontaneity, manifest joy, and sense of humor. Physical spontaneity referred to the level of movement and coordination during play. Cognitive spontaneity described the imaginative qualities of play and a child's willingness to assume different character roles and unconventional uses of objects. Social spontaneity emphasized flexibility in interactions with other children and a child's willingness to initiate play and interact with others. Manifest joy described a child's ability to express enjoyment and enthusiasm while playing. Sense of humor referred to a child's ability to clown around, tease, and joke with other children. Lieberman found that playful kindergarten children did better on divergent thinking tasks than non-playful children.

Building on Lieberman's work, Barnett (1991) developed a more reliable measure of playfulness which also supported that playfulness is a single characteristic that describes an individual's predisposition to play. Barnett and others explored relationships between playfulness and other personality traits. Barnett found that playfulness related to several personality descriptions, such as bright, active, aggressiveness, cheerful, self-confident, imaginative, impulsive, mischievous, and responsible. Other researchers found a strong relationship between playfulness and several adaptive personality traits like creativity, humorousness, emotional expressiveness, curiosity, openness, novelty-seeking, and communicativeness. In addition, children who were considered playful also demonstrated greater levels of positive affect, physical activity, communication, and imaginative and social behaviors in play than less playful children. Other researchers found a relationship between play and personality factors of positive mood, persistence, approachability, and adaptability.

Converging evidence suggests that children who are playful tend to be more flexible in their understanding of the world, more approachable, tend to initiate contact with others, and have an assertive style that may contribute to their ability to act adaptively when distressed. It may be that children who are naturally playful are more effective and efficient at dealing with their problems in their environment. Nonetheless, more research is needed to better understand the relationships between playfulness and positive adaptive behaviors.

Lieberman also discussed the importance of joy in playfulness. Children experience joy in play. Passion and the tendency to become absorbed in the task has been identified as crucial by many creativity researchers. To let passion and joy of learning develop in children is becoming increasingly difficult in our culture. Yet love of the task is necessary to help the individual tolerate all of the negative and frustrating components of the creative process necessary to make a major contribution. In play, children are beginning to experience the joy of getting lost in the task and doing something for the love of it.

Interpersonal Functioning

Vygotsky and Piaget were developmental theorists who believed that interaction through peers fosters problem solving and play development. Vygotsky identified a zone of proximal development, which includes tasks that are too difficult for the child individually, but are possible with guidance by adults or more skilled peers when the child is playing. Piaget also emphasized the importance of peers in the development of problem solving skills, but suggested the peers need not be more advanced. Through interactions with others at a similar developmental stage, children learn different perspectives, discuss possible resolutions, and decide on the best solution. Children develop problem solving skills, as well as advance their play skills, through this resolution process.

Pretend play is also related to understanding emotions of others, perspective-taking and empathy with other children. Paul Harris proposed that imaginative understanding may enable children to understand others' mental states and affective experiences. The research supports this proposition. Understanding the emotions and perspectives of others is important in a variety of domains such as fiction writing, poetry, screen-writing, play-writing, and song writing.

There is also a growing literature on the importance of having imaginary friends in childhood. Marjorie Taylor has done much of the research on the creation of imaginary companions during the preschool years.

Russ in 2014 summarized the play and creativity research and concluded that play is related to many of the cognitive and affective processes important in creativity. Much of the research is correlational but there are some well-designed experimental studies as well. Russ speculated that pretend play helps the child become more creative by:

1. Practice with free flow of associations that is involved in divergent thinking
2. Practice with symbol substitution, recombining of images, and manipulation of object representations
3. Expression of positive affect, which is so important in creative work. Playfulness and the love of the experience of getting lost in a task and experiencing joy
4. Expression of positive and negative affect themes in fantasy. The child develops access to a variety of memories and associations and manipulates affective symbols
5. Developing narratives that integrates and regulates the emotions
6. Expanding understanding of the emotions and perspectives of the other

There is definitely a need for more research that investigates the underlying processes and mechanisms that account for the well-established relationship between play and creativity in children.

Neurological Research

Recent research in neuroscience is relevant to pretend play and creativity. research. Neuroimaging studies have identified the default-mode network (DMN) as the brain system involved in spontaneous, self-generated thought (Beatty et al., 2016). This is the type of thought important in open-ended tasks requiring generating a variety of ideas. Pretend play is an open-ended task requiring self-generated thought. It is also the neurological network involved in incubation-the process of mind wandering and letting one's thoughts roam.

Beatty and his colleagues also identified the executive control network as being important in the creative process. The executive control network brings cognitive control and critical thinking functions to creative tasks. Creative tasks such as divergent thinking tasks involve both types of networks, an open-ended phase of idea generation and an evaluation phase that identifies solutions and refines the product.

Recent fMRI studies have found that there is a dynamic coupling between the default-mode network and the executive control network when people engage in different creative activities, such as poetry and musical improvisation. Vartanian reviewed research by Beatty and colleagues that found that more creative people had increased coupling between these two networks than less creative people. Vartanian suggested that there may be stable functional differences involving the coupling of these two networks in individuals. In other words, neurological differences may reflect better ability in creative individuals to switch back and forth between spontaneous thought and evaluative thought processes than less creative individuals. In pretend play, children switch between self-generated ideas and images and critical thinking skills required for creating a narrative. Pretend play provides practice with this switching activity.

Facilitating Pretend Play and Creativity

One way to foster creativity in children is through facilitation of pretend play ability.

There have been efforts to improve children's play skills. Many of these play training studies have been in an academic context rather than a therapeutic context. Smilansky's study in 1968 was one of the first to demonstrate that teachers could teach play skills. She worked with kindergarten children from low Social Economic Status (SES) backgrounds in Israel for 90 min a day, 5 days a week, for 9 weeks. The children who engaged in socio-dramatic play, with help from their teachers, showed significant cognitive improvement when compared with other groups. The teachers helped the children develop their play by commenting, making suggestions, and giving demonstrations. Play training has been found to be effective with mentally retarded populations. Additionally, in Austria, when compared with a control group, low SES elementary school children who were instructed in play 4 h per week had better divergent thinking skills and were happier in school.

One of the methodological problems with many studies in the play facilitation area is the lack of adequate control groups. Smith has consistently raised this issue in reviewing the play intervention literature. Smith stressed that adequate research design requires the inclusion of a control group that involves experimenter-child interaction of a form other than pretend play. He concluded that when this kind of control group is included, usually both the play group and the control group improve. Dansky reached a different conclusion after reviewing the play training literature. He concluded that many studies did have adequate control groups that controlled for involvement of the experimenter. Dansky concluded that there were consistently positive results in studies with adequate control groups that demonstrated that play tutoring, over a period of time, resulted in increased imaginativeness in play and increased creativity.

Lillard and colleagues in 2013 criticized the methodology of play and creativity research and concluded that there was no evidence that play facilitated creativity. Russ and Wallace (2013) reached a different conclusion, as had Dansky. However, Lillard's recommendations for rigorous play intervention studies using control groups and blind scoring, should be followed in future research.

Russ and colleagues investigated the effects of play intervention techniques on children's play skills and associations with creativity, coping, and life satisfaction. Participants were 50 first and second grade children in an inner city school (99% African-American). Children were randomly assigned to either the imagination play group, the affect play group, or the puzzles/coloring control group. Each participant met five times with a play trainer in individual sessions. A standardized play intervention was

used for each play group. This study found that the affect play group showed greater cognitive and affective play skills. The imagination play group showed greater affective play skills. It was also hypothesized that the play conditions would result in greater creativity, coping, and life satisfaction than the control condition. This turned out to be accurate with a significant effect of group play on creativity, coping, and life satisfaction.

The major result of this study was that the play interventions were effective in improving play skills. After baseline play was controlled for, the affect play group had significantly higher play scores on all play processes. These children had more affect in their play (both positive affect and negative affect), a greater variety of affect content, and better imagination and organization of the story than did the control group. The imagination play group also had significantly more positive affect and variety of affect than the control group. When we did a follow-up study of these children 4–8 months later, only the imagination group had improved play skills over time. Results for the affect group did not hold over this period. Also, the increase in divergent thinking did not hold.

The longer lasting effect of the imagination intervention on play skills is interesting and warrants more research. In general, the results are promising that a brief standardized play intervention can improve children's play skills, which may, in turn, enhance creativity, coping, and feelings of life-satisfaction. In a recent study, in a small group play intervention, after six small group play sessions that were facilitated by adults, [Hoffmann and Russ \(2016\)](#) found that children had increased imagination and affect in play, when compared to a control group who colored and did crafts. In addition, there was a transfer effect in that below-average players at baseline increased performance on a creativity task.

In a randomized controlled study with autistic children, [Kasari and colleagues, \(2006\)](#) found that a play intervention resulted in increased symbolic play. This was a very rigorous study that began the intervention at the child's current developmental level of play. The training involved modeling and prompting. Children in the play group, compared with the joint attention and control groups, had increased symbolic play that generalized to play with the mothers. This study is relevant to the area of creativity because children with autism have deficient pretend play skills. Techniques that facilitate play in these children should be effective with other groups as well.

[Erin Barton and Mark Wolery, \(2008\)](#) in a review of the literature on play with children with disabilities, concluded that there is a consistent relation between pretense behaviors in the child and adult prompting and modeling. However, there were many methodological problems with the studies. They did think that teachers could prompt pretend play in the classroom, but for generalization to occur, multiple exemplars of materials and multiple trainers should be used.

There is some research that guides parents in helping children to develop their play skills. Singer and Singer, in 1999, developed a video-based program for parents and other caregivers of preschool children that uses make-believe play to enhance literacy. This is a comprehensive program called *My Magic Story Car*. Children watch pretend play games on the video and then play the games. In a nationally tested study, they found that key literacy skills improved after the program was utilized. In addition, the majority of children continued to play the make-believe games on their own without adult intervention and teach the games to other children.

The building of empirical research on specific play interventions is encouraging and needs to continue. Future research should continue to identify the specific prompts and techniques that facilitate play. More randomized controlled studies with rigorous methodology are needed. Hopefully, these prompts and techniques could be adapted to a variety of settings and child populations. Dissemination of the scripts to parents and teachers for everyday use is an important next step.

Changes in the Culture of Play

Time for free-play has decreased over the past fifty years. Children are heavily scheduled for structured activities and the computer and videogames have taken over much of children's free time. The decrease in unstructured play time has occurred throughout the world. Children do not have enough opportunities to be involved in unstructured activities. The American Academy of Pediatrics, in a 2007 report, called for an increasing recognition of the importance of play in child development. However, even considering the shift in focus, [David Elkind, \(2007\)](#) suggested that children maintain the same desire to play. Although there are fewer spaces and less designated areas of play, children continue to play games and create learning experiences. They reinvent outdoor areas for make-believe games and change routine activities into games of finishing first or lasting the longest. Although it is difficult to generalize, it seems that many children continue to foster their creativity and problem solving through play.

Russ & Dillon reviewed play studies from 1986 to 2008 with different school-based populations that used the same standardized play task, instructions, and scoring system (Affect in Play Scale). They found that the organization of the play narrative and amount of affect expression has remained stable over this 20 year period. Imagination in the play narrative has significantly increased in recent years. These findings suggest that children are finding ways to develop abilities to express imagination and affective expression even though there is less unstructured time available to them.

Conclusion

Research supports the relationship between pretend play and creativity. Both cognitive and affective processes that are important in creativity occur in play and appear to be developed in play. The studies that are developing play interventions that facilitate play skills and creativity are crucial in expanding understanding of if and how play helps child development. Increasing sophistication of research design, measurement tools, and play facilitation techniques are necessary to move the field ahead. The study of the individual child is also important to include in researchers repertoire. Fein's study of master players continues to be a rich source of information and research ideas. If research evidence can continue to be built that play facilitates creativity and child development in general, then this finding will make a strong argument about the importance of play in order to influence social policy. In the meantime, children will continue to find ways to develop their imagination and find time to play.

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Poetry

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As seen through the lens of creativity research, poetry is a multifaceted and complex domain. The importance of creativity in poetry may be best understood in the exploration of expert-level poets as opposed to studying a layperson's journey through what would be considered everyday poetry creativity. Instead, the observation of more eminent levels of poetic writing serves a greater purpose in many ways on gaining a full understanding of the scope poetry covers. First, understanding the functional process of writing poetry allows for a foundational knowledge of the nuanced process of writing poetry. Adding the intricacies of the creative process, allows the reader to see not only how it uniquely relates to poetry, but also how the poetic process sets a gold standard for the creative process.

Poetry itself is an elusively held topic in modern psychology. Experimental psychologists are often significantly more interested in the way the human mind invents or enters into narrative worlds (e.g., [Gerrig, 1993](#)) as opposed to how the mind produces poetry. The interest in poetry has tended to focus more on the nature of poets as opposed to poetry itself. This has led to comprehensive research about poets, particularly their rates of mood disorders. This association may very well originate from the idea that mind wandering is a key driver of poetic thought. Thus, it is an easy gateway to rumination, which is not at all uncommon among poets ([Kaufman and Baer, 2002](#)).

Poetry Through the Lifespan

In examining the development of poets, it is important to trace common patterns in lifespan and achievement. For example, in a study of 420 literary greats, the mean age of fiction writers to produce their best work was at 42.6 years old, whereas for poets it was 38.5 years old ([Simonton, 1975](#)). As a group, poets tend to peak at a statistically young age. Along with physicists, if poets do not create a major work by age 25, they are unlikely to ever do so. Further, poets produce double their lifetime output in their twenties as do their novelist counterparts ([Simonton, 2009](#)). Poets who began their journey by publishing their work at approximately 25 years old or younger statistically produce more poetry than those who begin their publication journey around age 30 ([Kaufman and Gentile, 2002](#)). Perhaps a better way to conceptualize these peak achievements is to look at what [Simonton \(2009\)](#) described as a poet's career age. He found that a poet's peak work occurs on average 20.1 years into their career (for comparison, a novelist's peak work happens around 27.1 years).

An alternate theory argues that different types of creators peak at different ages ([Galenson, 2005](#)). In one life cycle, early conceptual creators (or finders) enter prominence within their domain via a massive burst of greatness. In the life cycle of seekers, creators find their peak later, making contributions over a broad body of work. [Simonton \(2007\)](#), however, found historiometric evidence that the domain (in his study, poetry vs. fiction) is equally important in predicting when a writer will peak.

The Poetic Mode of Thought

The creation of poetry is ingrained in processes that are distinctive from processes that are more typical in science-driven or narrative styles of writing. [Bruner \(1962\)](#) coined the distinction between the paradigmatic and the narrative modes of thought. The paradigmatic mind is interested in objectivizing; the narrative mind is interested in subjunctivizing. Yet that distinction does not capture what is specific about the poetic mode of thought. Poetry also involves subjunctivizing, yet it deals with intentionality in a different fashion. That difference was well expressed by Auden when he noted, "[l]anguage is prosaic to the degree that 'it does not matter what particular word is associated with an idea, provided that the association once made is permanent'. Language is poetic to the degree that it does matter" (1990, p. 35). In summary, the main differentiating factor is how narrative and poetry deal with the issue of intentionality. Narratives express intentionality through characters; poetry expresses intentionality through language. That said,

as Borges noticed, in its origin, poetry is engaged with the telling of a tale (i.e., with a narrative) such as “the tale of Troy, the tale of Ulysses, the tale of Jesus” (2000, p. 47).

In order to express intentionality through language, poetry engages two senses: the auditory and the visual. As Hollander stated, “poetry is a kind of music, as it is a mode of picturing in the context of the eye” (1975, p. 3). Creating poetry involves (among other components) meter, rhythm, and rhyme. Principles regulating meter in poetry depend upon the arrangement of syllables and accents in each verse. Some poems are created with syllabic meter (i.e., according to the number of syllables), others with accentual meter (i.e., according to the number of stressed syllables), and others with accentual-syllabic meter (i.e., according to the alternation of stressed and unstressed syllables such as English iambic lines. Although not adhering to a strict meter, free verse also requires some sense of rhythm.

In fact, there are many ways a poet can create rhythm, before meaning is even contemplated. Hollander mentions “syllable sequence, stress pattern word boundary, modulations of stress pattern because of phrase grouping, additional prominence to syllables being given by internal rhyme, assonance, or alliteration” (1975, p. 33.) Hollander noticed rhyme has mnemonic, schematic, musical, and semantic effects. Yet the building blocks of a poem are not only based on its oral/auditory qualities. Hollander said that “the poem in the eye as a kind of picture, and one of the things we do when read a poem is to discern visual structures, to make out parts, wholes, relationships to see patterns in sub- and total contexts, and so forth” (p. 246).

The primary visual structures of a poem are its lines and stanzas. Beyond lines and stanzas, some authors took this visual component to extremes such as Apollinaire in his calligrammes or Augusto de Campos in his concrete poetry. This visual component is particularly important in Chinese poetry, where calligraphy plays a central role as a particular art bordering painting.

In the functional writing of poetry even minor changes in the visual and auditory components used in a poem can lead to a large transformation of meaning. In poetry writing, this linguistic importance lends itself to understanding its auditory and visual component. As language is an integral part of conveying meaning, so are rhythm and the text’s visual arrangement. In the writing process, a poet not only delivers a specific message but also produces an accompanying rhythmic voice, which in turn has to be placed in print. So, poetry is an oral art represented in print. The poet is, partially, both a composer and a painter. And, mostly, a language whisperer. As Pinsky (1998) stated, “Poetry is a vocal, which is to say a bodily, art. The medium of poetry is a human body: the column of air inside the chest, shaped into signifying sounds in the larynx and the mouth” (p. 8). That said, those sounds are conveyed visually.

Creative Process of Writing Poetry

In any form of writing, a challenge all authors and scholars face is the challenge of keeping the mind focused on a given task. The act of writing, especially in conventional styles, taxes a large portion of the mind’s working memory resources and other cognitive activities. The main processes involved in writing are planning, translating and producing text, and reviewing, acting as three interactive processes (Kellogg, 1994). To add to this mental taxation, this interaction also involves dealing with problems in different mental spaces. That is to say, distinct dimensions of language including grammar, semantics, and pragmatics must interact and develop coherently. Mature writers are easily able to take rhetorical needs into consideration when solving content issues, and vice versa when dealing with the reverse (Bereiter and Scardamalia, 1987).

Writing has specific qualities that pertain to the domain of creativity. Runco (2009) said that, first, “one way to describe writing’s unique advantage and benefit is in terms of the amount of detail and exploration allowed by writing” (p. 185); and, second, that “writing is best described as a process than a product, and may be that very process that benefits the writer” (p. 188). That rings true for all forms of writing, but it is particularly true of poetry.

In fact, Bruner used the writing of a poem to exemplify the nature of the creative process: “You begin to write a poem. Before long it, the poem, begins to develop metrical, stanzaic, symbolical requirements. You, as the writer of the poem, are serving it – it seems” (Bruner, 1962, p. 25). It is notable that Bruner called that process *freedom to be dominated by the object*. This freedom to be dominated by the object is what gives mind wandering such powerful role in the process of poetic meaning making. Thus, the act of writing and composing poetry serves to epitomize the nature of the creative process in writing. In conventional writing, defocusing attention may detrimentally negatively impact this process. However, in poetry, mind wandering is a skill employed by expert poets. Poets must be disposed to allowing for an active suspense of focus, mindfully wandering to allow language to fall into place and settle in a perfect form, both orally and visually (Preiss and Cosmelli, 2017; Preiss, 2019).

The uniqueness of the generative process of poetry may lie in the suspension of attention that is so dominant in other forms of writing. After a poet initially generates a basic idea for a poem, traveling inward to find a theme, the ability to productively mind wander defocuses the mind’s attention to the obvious task. In this way, mind wandering can be pointed out as one of the main components that defy the mainstream notion of expert level writing. In poetry, the initial planning stage is less clear-cut, challenging the idea that planning is a necessary step in producing a text. And yet revision ends up playing a prominent role in poetry; it allows for the correction of the natural aesthetical excess mind wandering calls for.

One of the biggest challenges a poet faces is to produce novelty, a paradigmatic signature of creative behavior. Although the combinations allowed for language are infinite, there are just enough patterns in the world to be sung, as Borges (2000) stated. A countless number of poems have been composed about a countless number of subjects, and it is up to the creative poet to find themselves outside of the current body of work. It is unsurprising that Rilke said in his letters to a young poet: “Do not write love poems.” (2011, p. 31) As one can imagine, love has remained one of the central subject matters in poetry. As a poet, if you want

to say something new about love, you also have to deal with the entire history of poems pertaining to the subject. Many others before this point in time have found his or her own voice, and the poet must do the same for their own voice and originality both among his or her forerunners and his or her contemporaries. [Borges \(2000\)](#) thought that although hundreds of metaphors could be invented in the search for originality, poets deal primarily with a few patterns behind those metaphors.

Recently, four distinct steps were identified in the process of creatively writing poetry. Briefly, these steps are: acknowledging extended time, developing trust in incubation, incorporating the creative process as a part of identity development, and recognizing the positive impact of creativity on overall well-being ([Preiss and Cosmelli, 2017](#)). Acknowledging extended time refers to the idea that creative writing takes an extended amount of time both on and off task. Second, trust and incubation refers to the idea that poets develop a sense of strategic mind wandering. "Acknowledgment of the role incubation plays on creativity is part of the process of building a self continuously engaged with the creative process." ([Preiss and Cosmelli, 2017](#), p. 306). Chilean poet Veronica Zondek said clearly:

If I don't write, I review what I have written; if I don't review, I am reading something that is close to it; I relate to what I am doing but not necessarily through writing... On the other hand, I have learnt to use those lapses of time such as when I am in the subway, the night, moments between work, between gardening or putting things in the oven.

Quoted in [Preiss and Cosmelli](#), p. 307.

Third, seeing the creative process as identity development is based on the idea that poets write because they intrinsically feel that they must write, which is consistent with the view that authors such as Rilke had about the act of being a poet. Rilke said:

There's only one way to proceed. Go inside yourself. Explore the reason that compels you to write; test whether it stretches its roots into the deepest part of your heart, admit to yourself whether you would have to die if the opportunity to write were withheld from you. Above all else, ask yourself at your most silent hour of night: *must I write?* (2011, p. 30)

Finally, the fourth step notes the understanding that the writing process is an extended process aiding in understanding how writing gives authors a set sense of closure. These four steps are linked by an extended process of mind wandering around a singular topic, immediately followed by the more focused attentional state in the process of revision.

A key point in the psychological view of creativity is that the creation of poetry is, in its nature, a life-time commitment. Even when a poet is not producing a text, it is instinctual to be naturally mind wandering about writing. In this way, as [Preiss and Cosmelli](#) suggested, poetry is the most intensive version of the creative process; the poet is always writing, even when they themselves believe they are facing writers block. Eminent poets are in a permanent state of searching for poetic insights, which often blurs the line between artistic and vital. In what is called the years of silence in the development of expertise, poetry takes on a very unique nature ([Weisberg, 1999](#)).

Poetry and Mental Health

Even within different creative domains, specific subgroups can differ widely in their rates of mental illnesses. For example, as measured by suicide attempts, hospitalizations, or periods of depression (as described in a brief biography), eminent female poets were found to be significantly more likely to suffer from mental illness compared to female writers in other domains (fiction, playwrights, non-fiction) and male writers in any domain. They were also more likely to have a described episode of mental illness compared to women in other eminent areas, such as acting, politics, and business ([Kaufman, 2001](#)). This finding became known as the "Sylvia Plath Effect." In additional studies, it has been found that eminent poets were more likely than other domains of creative writers to be mentally ill and show cognitive distortion ([Thomas and Duke, 2007](#)).

The healing power of narrative writing may be what is responsible for the Sylvia Plath Effect ([Kaufman and Sexton, 2006](#)). The creation of a story is the pivotal component of the healing effects of writing; yet as previously mentioned, poems do not carry the same narrative importance as other types of writing. Poems do not necessarily tell stories with a beginning, middle, or end, whereas most plays and stories do. As a result, there is little evidence as to why poetry would have similar benefits to other types of writing. For example, one study had participants either write a Haiku poem or a narrative over different occasions. The people who wrote narrative were less anxious and depressed, whereas there was no effect on the Haiku group ([Stephenson and Rosen, 2015](#)).

One line of research looks at how the actual linguistic distinctions writers use can be consistently associated with mental health. Suicidal poets are more likely to use words highly associated with the self in their poetry, whereas non-suicidal poets use collective language ([Stirman and Pennebaker, 2001](#)). This tendency is indicative of an inward focus as well as a lack of social integration. For example, linguistic patterns of eminent writers displaying bipolar behaviors used more death related words than the population showing unipolar patterns of behavior; unipolar writers were less likely to use self-related words than the normative population ([Forgeard, 2008](#)).

Conclusion

Writing poetry is not only about creating poems. It involves also dealing with the creative potential of a conscientiously unfocused mind so it can reach the required attentional disposition that enables the writer to produce new metaphors about universal themes. In so doing, the poet must deal with both the oral and visual components that give shape to a specific poem. The multiple combinations allowed by these components (in different linguistic and cultural traditions) is what gives poetry its incredible generativity. The translation of poetry was not addressed here yet the challenges poetry poses to translation rest on the fact that each language has its specific oral and visual qualities. Poets become true geniuses when they convey a universal message notwithstanding working with culturally specific material. At the end of the day, it is the creative process what makes all literature meaningful and universal. Poetic meaning making through the conscious use of our disposition to mind wander rediscovers and reinvents continuously the aesthetic powers of language.

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Politics

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Glossary

Bidirectionality Causal relationships that work in two direction, with A sometimes causing (or influencing) B, but other times B sometimes causing (or influencing) A. Bidirectionality has been uncovered in many studies of creativity.

Periodization of Influence The expression of creativity may vary from era to era, and sometimes the changes are regular and follow a pattern. It has been called “the clockwork muse.”

Paradigm shifts Thomas Kuhn’s idea that science progresses incrementally but at some point assumptions are questioned and there is a radical paradigm shift where those assumptions are rejected and often a new worldview is introduced.

Hidden Variable Problem Sometimes two things are correlated but not causally related because they both depend on some third, hidden variable that is actually the causal factor for both manifest variables. The correlation is, then, misleading.

Individualism A philosophy and ideology which respects individuality. That individuality is associated with autonomy and creative expression. Individualism and creativity are also associated with Liberalism.

Psychological Freedom A condition in homes, schools, cultures, and nations which allows authentic self-expression and thereby creativity.

21st Century Skills Creativity, Communication, Critical Thinking, and Collaboration. Research shows that creativity is the least supported by the Federal government, at least in terms of grants given.

Introduction

This *Encyclopedia* chapter reviews research that suggests relationships between politics and creativity. The plural, relationships, is vital, for although the research is scant, various associations are suggested, not just one. In fact, several of the connections work in one direction, with human creativity influencing what politics are offered and endure (i.e., the creative ones), but other associations suggest the opposite causality, with political situations determining how creativity is identified and supported—or not supported. This *bidirectionality* should not be much of a surprise because it also characterizes economics and other macro-level influences on and results of creativity (Runco, 2014).

This chapter reviews examples of how politics influences creativity, and examples of how creativity influences politics. It first extends the idea that the relationships between politics and creativity are complicated. These complications must be identified before the specific relationships are identified. Those relationships between politics and creativity only make sense once the complications are recognized.

It may be easiest to begin by describing the influence of creativity on politics. Several volumes, including *American Creation* (Ellis, 2007) and *A Great Improvisation* (Schiff, 2005) help with this sort of thing, the idea being that the American Democratic Republic was itself a result of creative efforts. Other specific political products which resulted from creative efforts can easily be listed, including the US Constitution and the Magna Carta. Research has pointed to political speeches as creative artifacts, as well. Katz-Buonincontro (2012), for example, quoted speeches by Barack Obama and Bill Clinton to illustrate. This line of work is justified by respected methodologies which were developed to examine the creativity of all kinds of verbiage (Runco et al., 2015). In fact the well-known theory of language put forth by Chomsky (1966) implies that all language is creative. People use a finite set of rules to generate meaning in an original fashion (i.e., saying something they have never said before) just about any time they open their mouths, or at least regularly. Consider next the political method often called “spin.” Here information with one meaning or implication is altered in a creative way such that the negative connotation is less apparent and a more pleasing message is more readily apparent. When “spin” hides factual information and does damage, it would certainly qualify for *malevolent creativity*.

The other direction of effect may be more important. This has political conditions and decisions influencing creative efforts and creative behavior. A number of scholars have considered this direction of effect. Seitz (2003), for example, examined this possibility and concluded that creativity and self expression, as well as entrepreneurship, varied with the distribution and redistribution of power and resources. He identified copyright restrictions, corporate control, and religious and political censorship as influences.

Note his inclusion of entrepreneurship. This is important because politics does not just influence creativity. It influences various things, including innovation, entrepreneurship, and various forms of self-expression. Also interesting is that Seitz referred to a *periodization* of influence, a term that refers to creative expression as it varies and cycles through history. A periodization of creativity described earlier in Colin Martindale's (1990) *A Clockwork Muse*. Similarly, periodization plays a central role in Thomas Kuhn's theory of paradigm shifts (i.e., periods of normal science and then revolution).

The relationships of politics and creativity are even more complicated than bidirectionality may suggest. What was just presented suggests two directions of effect, with creative individuals producing creative political products (e.g., speeches, policies, documents such as the Magna Carta, and even sound bites which are nothing but "spin") as well as political conditions influencing how creativity is expressed and supported. Further complication is indicated by the possibility of a third causality where both creative expression and politics are influenced by some other underlying variable. This should really come as no surprise, given how often the same thing has been found in a wide range of correlational research. It even has a name: "the hidden variable problem." It is a problem because correlational research is designed to uncover relationships. They are not causal relationships. They are just associations with unknown causality. Even if there is a high correlation, one of the variables involved could be causing the other (A causing B), but it could be that the opposite is true (B causes A). The correlation does not indicate which causes which. In fact, there could be a third hidden variable that actually causes both (C causes both A and B) and thus A and B are not actually causally related at all! Instead they both depend on the third variable.

This sort of thing was implied by the theory of Karl Marx. Runco (2014, p. 306) quoted Marx as saying, "art and politics are the surface manifestations of the same underlying social order." In this light there is some underlying social order, which may be related to cultural values or some broad ideology, and that social order in turn leads to artistic expression (one kind of creativity) but it also independently leads to political situations. Perhaps more clearly are the philosophies that also operate as hidden variables, influencing both creative expression as well as manifest politics. Seitz (2003) seemed to be aware of the interplay of cultural values and political policies when he described how

A theory of government and society that became increasingly influential in the 17th century, liberalism, created the conditions for individualism. These conditions are currently demarcated in contemporary Western democracies according to three premises. The first premise requires that all citizens receive equal treatment and consideration, independent of any particular conception of what is an acceptable lifestyle—that is, one either advocated by state ideology or formal government intervention. Similarly, the second and third premises set the conditions for individualism by endorsing both representative democracy and a market economy, as these promote the economic and ethnic equality of all citizens Thus, by institutionalizing fair and equal consideration of the needs of all citizens within a system of market relations and political representation of the people's will, liberalism fosters creative production by encouraging individual creative expression. (pp. 389–390)

This points clearly to the connection of liberalism and individualism goes a long way to explaining why individualism supports creativity. Individualism allows individuality; and individuality and its correlates (e.g., autonomy, independence, nonconformity) play an important role in creative effort because creativity depends on originality, and originality assumes that the person has done something that is unique and different from what others have done. In sum, the originality that is the basis for creativity is possible and perhaps encouraged in Liberal political conditions.

Political Liberalism

There various reasons to look to Liberalism as the philosophy that is the most likely to support creative expression. These reasons show that it is not an apples-and-oranges sort of thing, either, where one kind of creativity is associated with Liberalism and another kind associated with Conservatism. Instead, creativity is more likely in a Liberal society, and conventionality and conformity more likely in a Conservative society. There is a functional connection between Liberalism and creativity such that the latter is supported, and a functional connection between Conservatism and conventionality such that the latter is supported. These functional connections are logically and theoretically apparent, and supported by empirical data.

Ferris (2010) went into great detail about the connection between Liberalism and creativity. He explored the logical connection, which is compelling, but he also offered support by examining various historical eras and famous creators. Holland represents one of many fascinating and convincing examples. . As Ferris (p. 63) described it,

The Dutch were the architects and beneficiaries of what would be known as their Golden Age (1609–1713), an era during much of which Holland was pretty much the freest—and per capita the wealthiest and most creative—nation in the world. The Dutch dominated world maritime trade.... They counted among their philosophers immigrant freedom seekers like Descartes; the liberal skeptic Pierre Bayle, whose *Historical and Critical Dictionary* of 1697 would find its way into Thomas Jefferson's list of the 100 books vital to establishing the American Library of Congress; and now John Locke.

The phrase "wealthiest and most creative" is of obvious importance to the present chapter, but note also the various domains that are mentioned in that quotation, including maritime trade, which led to the founding of New Amsterdam (New York), a huge commercial success, as well as philosophy. But the benefits of Liberalism are even broader. Again quoting Ferris (2010, p. 64),

The Dutch innovated oil painting [and] created new styles of painting as well, influenced in part by the use of optical devices such as the pinhole camera, the refracting or 'Gali-lean' telescope, and lenses which could project an inverted image onto a blank canvas. One such projector is thought to have been developed by the naturalist and microscopist Antoni van Leeuwenhoek and employed by Johannes Vermeer, both of whom worked in Delft.

Dutch artists expressed their appreciation of Liberalism in the sense that "Dutch paintings celebrated freedom, industriousness, and prosperity" (p. 64). Note the recognition of the benefits of Liberalism for science, as well as for art, and the idea that Dutch artists took advantage of scientific innovations.

Ferris (2010) elaborated on the fact that the Liberalism of the Dutch had great influence on John Locke, "architect of the Enlightenment." More concretely Locke was author of *Letter Concerning Toleration*, *Essay Concerning Human Understanding*, and *Two Treatises of Civil Government*. Locke's thinking directly influenced the Framers of the US Constitution. Ferris describes dozens of other historical examples and case studies showing the benefits of Liberalism, many for creativity and individualism.

An important part of Liberalism is freedom, which of course is at the heart of many governments and thus an important political concern. Freedom is a useful term in this chapter because many studies have supported the role of *psychological freedom* in creative efforts. Frank Barron was quite clear about the benefits of psychological freedom for creativity, as is especially clear in his volume, *Creativity and Personal Freedom* (1968). Empirical studies have also supported the benefit of psychological freedom for creativity, including those of Harrington, Block, and Block (1987). They examined how various parenting styles provide children with more or less freedom and how optimal freedom seems to support children's creative thinking. This line of work tests earlier work by Carl Rogers. A critical concept in Rogers' thinking was "unconditional positive regard," which he explained as providing individuals with respect so they were free to be themselves and to be spontaneous and creative.

This discussion has not drifted from the topic of politics. The previous paragraph or two merely explores specific benefits of Liberalism and any political support for individuality and freedom. These benefits are apparent on all levels, including societal, familial, cultural, and individual.

Voting and Creativity

Some governments allow voting, and several empirical investigations have examined voting as it is related to creativity. This research is fairly rigorous as well as empirical and has direct implications for the discussion of creativity and politics. There is an important assumption in this research, namely that creativity is expressed in invention. This is an easy assumption to accept, though certainly there is more to invention than just creativity. This is especially true when the measures of invention used in the research focus on patents, for those would require knowledge about the patent system as well as creativity. Still, it may be impossible to obtain a patent without some creativity. As a matter of fact the requirements for a patent are remarkably similar to the dimensions of creativity found in the work of Simonton (2012) and others. These include novelty (or originality), utility (or effectiveness), and surprise. No wonder research often does look to patents as a concrete expression of unambiguous creativity.

Some of this research is directly relevant to the present discussion because it has examined how patents are related to voting patterns. In one investigation McCann (2011) looked at the voting patterns of the two US Presidential elections involving the 43rd President, George W. Bush. McCann started by classifying every state in the US as "blue" (Democrat) or "red" (Republican). Although this is a big generalization, given that many voters in a red state actually vote democrat, and many voters in blue states actually vote republican, the Electoral College system used in United States makes similar generalizations (Subsequent research, summarized below, avoids this generalization). McCann also obtained data from the US Patent and Trademark Office about the number of patents granted in each state. Come to find out, there were significantly more patents granted in blue states compared to red states, even when various statistical controls (e.g., degrees of urbanization, SES, and IQ) were included in the analyses. McCann's conclusion focused on the fact that red states tend to be more conservative, and blue states more liberal. In addition to the benefits of Liberalism for creativity mentioned above, there is also the fact that Conservatism by definition tends to protect the status quo and avoid change. This in turn could easily minimize creativity because creativity always introduces something new.

McCann (2011) also reported data from a project where 141,000 households were telephoned and various personality traits estimated. This indicated that Openness was related to the number of patents awarded, which makes a great deal of sense given that Openness is the personality trait that is associated with creativity more than any other trait.

Runco et al. (2017) extended this research but offered a more fine-grained analysis. Instead of looking at state-level voting, they obtained county-level data, which meant a much larger sample size (over 3000 counties rather than a mere 50 states) and, as a result, more robust analyses. Their voting data were from the 2016 (Hillary Clinton versus Donald Trump) election. But their results quite similar and, like the previous work by McCann (2011), showed blue states to have significantly more patents granted than red states. The control variables included educational level, socioeconomic status (SES), income, and diversity within each county. Two metrics were found in the US Census data that allowed examination of diversity. The first was *racial diversity* and based on a ratio of individuals, within each county, who chose two or more races when taking the 2015 Census. Linguistic diversity was also based on US Census data (online). It reflected the proportion of homes, within each county, where some language other than English was spoken. Findings indicated that the number of patents granted within counties was negatively related to Conservatism and positively related to educational level and racial diversity. The finding about racial diversity is no surprise, given theory and research

that diversity of various kinds is beneficial to creativity. The finding about Conservatism is consistent with other results, summarized above, showing a positive relationship of creativity with Liberalism and a negative relationship of creativity with Conservatism.

Conclusions

Several kinds of data were summarized in this chapter, including those reviewed last and based on voting patterns and the number of patents granted (as an index of creativity). This entry began with a summary of relevant case studies and the historical analysis of Ferris (2010). Admittedly case studies by themselves have limited generalizability, but in the present case they are consistent with the other more experimental data. In fact there are other data suggesting a relationship between political conditions and creativity. Simonton (1984, 1997), for example, looked to various events, including international war, civil disturbance, and political instability, as indicators of particular political conditions. Each of these events was, at different times through history, associated with estimates of creativity and productivity. Zysberg and Schenk (2013) examined political orientation and creativity and reported that both social and political attitudes were associated with creative potential.

One convincing explanation for why political policies are related to creativity and its correlates points to resources. Policies determine how resources are allocated, and apparently Liberalism tends to allocate resources such that creativity is supported. With this in mind Abdullah and Runco (2018) decided to compare the frequency with Federal grants are awarded to creativity, in comparison to how many grants are awarded to other similar topics, such as scholastic achievement and general intelligence. They looked to data about awards given by the National Science Foundation (NSF) and Institute for Education Sciences (IES) from 2005 to 2016. Awards for creativity research were compared with awards given to the other three 21st Century Skills, namely collaboration, communication, and critical thinking. Results indicated that creativity was supported least of all four skills. Both agencies funded critical thinking with regularity. The NSF also funded collaboration with some regularity, and IES funded communication, as well as critical thinking. This research may exemplify how policy leads to the allocation of resources, but it may also be a reminder that creativity is not easy to operationalize. Creativity is one of the 21st Century Skills, but it is not funded as well as the others, perhaps because grants require good operationalization and evaluation, both of which might be undermined by debates about how to best define and measure creativity.

This possibility may be added to the other complications, mentioned early in this chapter, which lead to difficulties in studying how politics is related to creativity. These included the ambiguous causality, and possible bidirectionality, as well as the possibility that apparent causal relationships actually reflect hidden variables. Certainly much is difficult to operationalize when studying both politics and creativity. Given that politics may determine how resources are allocated and thus determine whether or not creativity is supported, more research on this topic is warranted.

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Polymathy

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Introduction: Defining Polymathy

According to the Oxford English Dictionary, “polymath” originated in the early 17th century to designate a person of wide knowledge or learning. Since that time, the term has often been linked with “Renaissance man” and with the idea that the wide knowledge be used for some practical purpose or integrated in some effective way. The apparently minor differences in these two understandings of polymathy have important consequences for creativity studies, and both leave key aspects of the phenomenon unresolved. To begin with, should passive knowledge be enough to qualify a person as a polymath? One of us once met an individual who had acquired twenty-three master’s degrees. As he himself admitted, he never used his knowledge practically; he simply loved to learn. By one definition, this man was a polymath; by the other, not. What, then, is the relationship between breadth of learning and productive outcome and creative productivity.

Other issues left unresolved by competing definitions of polymathy concern impact and incidence. Some creativity scholars have suggested that only individuals achieving eminence in multiple disciplines, in the manner of Hildegard of Bingen, Leonardo da Vinci, Andreas Vesalius, Maria Gaetana Agnesi, Benjamin Franklin, or Sofia Kovalevskaya, should qualify as polymaths. Advocates of this position argue that polymathy is rare, not least because today’s rapid expansion of knowledge, intense scholarly competition, and deep disciplinary specialization militate against mastery of more than one domain or field of endeavor. However, other scholars place the bar for impact much lower, suggesting that polymathic ability is not only common, but teachable. Does either position—or both—best capture the polymathy-creativity connection?

To address these questions, Root-Bernstein and Root-Bernstein proposed that, in certain circumstances, polymathy might indeed be qualified as creative, and that creative polymathy be defined as “active engagement in multiple interests or endeavors that draw upon or synthesize vocations and/or avocations, simultaneously or serially, across the lifespan.” Distinguishing between polymathy and creative polymathy leaves open the possibility that individuals (such as the multi-masters-degree holder mentioned above) might be polymathic without being creative. The converse, however, is problematic. If one understands creative problem-solving as the integration of two or more ideas, methods, concepts, principles, techniques, or materials in a novel and effective manner, it is not possible to be creative without being in some measure polymathic.

Moreover, to say that the creative polymath must be “actively” (rather than “productively”) engaged expands the notion of what that measure might be. Individuals may play and compose music without ever performing publicly; they may learn mathematical methods without ever inventing new problems or proofs. Yet these private activities can develop skills and understandings useful to the polymath’s public contribution in other disciplines. Hjerter (1986) and others find, for example, that many successful poets, novelists, and playwrights have been “Sunday painters” or “closet artists” who purposefully used their artwork to explore ideas that informed their writing. Eliminating the need to be publicly productive in all endeavors opens the door to amateur pursuits carried out intensively over long periods of time as qualifications for creative polymathy (See AVOCATION, this volume).

The Relationship Between Avocation, Breadth of Interest, and Creative Accomplishment

Avocational activity has long been associated with eminence. Over 150 years ago, Galton noticed that British “geniuses” and members of the Royal Society tended to have multiple mechanical, musical, literary, dramatic, and artistic hobbies. Van’t Hoff (1878) concluded from a convenience sample of over two hundred scientific biographies that what distinguished the most creative scientists from their less successful colleagues was imagination “manifest[ed] in ways other than their researches.” These manifestations included arts and music, as well as philosophical and religious writings. In the early 20th century, similar results were reported for scientific and mathematical ability by Ostwald in his book *Grösse Manner* (1909) and Mobius in *Ueber die anlage zur mathematic* (1900). Beyond the sciences, Cox (1926) and White (1931) concluded that what differentiated the genius from

more average peers was “versatility.” In White’s words, “range of interests is not the same as range of ability and we need both components to make our point! ... [h]e surpasses him in range of ability” (1931, p. 482). [Raskin \(1936\)](#) and, more recently, [Simonton and Cassandro \(2010\)](#) confirmed that an adaptable range of interest is a direct correlate of eminence.

Avocational activity or versatility is not limited to the eminent, however. [Milgram et al. \(1997\)](#) studied career success among several thousand Israelis and found that the single best predictor was having one or more mentally challenging avocations practiced over extended periods of time. Root-Bernstein and colleagues have generally found that acquisition of training in more than one discipline, either formally or informally, appears to be reasonably common (see Part III, below). What differentiates eminent individuals from others is not the polymathic interests per se, but the influence of extra-professional interests on professional purposes. In a study of 38 scientists, [R. Root-Bernstein et al. \(1995\)](#) found that the eleven most eminent among them (all Nobel Prize winners and/or members of the U. S. National Academy of Sciences) spoke of utilizing their avocational interests to generate novel ideas and stimulate their vocational creativity. In contrast, the twelve least successful scientists in the cohort uniformly described their non-scientific activities as regrettable wastes of time to no vocational effect.

As [Dewey \(1934\)](#), [Gruber \(1988\)](#), and [Root-Bernstein \(1989\)](#) have independently argued, the creative polymath sets him or herself apart from others by the purposeful integration of interests, respectively referred to as an “activity set,” a “network of enterprise,” or “correlative talents.” Gruber has documented perhaps the most extraordinary example of interest integration—that of Charles Darwin, who networked geology, geography, zoology, botany, paleontology, animal husbandry, agriculture, anthropology, and psychology into a unified theory of evolution by natural selection. Similar observations of creative activity sets have been made about Herman von Helmholtz and the dozen other German scientists who founded the 1847 Biophysics movement by [Crane \(1966\)](#), who documented a direct correlation between the number of different scientific, philosophical, and cultural interests each scientist had and how many fundamental contributions they made to the newly unfolding science. His study, as well as Gruber’s, suggests that creativity may be fundamentally combinatorial, an argument first proposed by Ostwald: the greater the range of problems, ideas, principles, methods, materials, and processes that an individual actively integrates within a personal network of interests, the greater the potential for creative outcome.

A combinatorial understanding of creativity might explain apparent conundrums such as simultaneous discovery or general creative ability. [Simonton \(2004\)](#) explains simultaneous discovery as a random, stochastic process. A closer look often reveals that simultaneous discoveries and inventions arise from polymathic individuals with similar training and interests working on shared problems or challenges ([Root-Bernstein, 1989](#)). From a combinatorial perspective, each of an individual’s interests need not be expressed separately in public forms of productivity, but will be integrated into the creative outcome of the polymath’s efforts.

The previous conclusion is something of a contentious point, since polymathy and general creative ability are often conflated. [Kaufman and Baer \(2004\)](#), for example, ask whether the physicist Stephen Hawking might have devoted himself to music or the singer Madonna might have taken up mathematics to creative acclaim equal to that of their first vocations. The two scholars advised Hawking and Madonna to stick with what they knew best. Strikingly, the career choices made by some contemporaries contradict Kaufman and Baer’s counsel. Consider the case of the child actress Danica McKellar, who starred in the television series “The Wonder Years.” McKellar earned an undergraduate degree in mathematics at UCLA, where she coauthored a paper that introduced what is now called the “Chayes–McKellar–Winn theorem.” She currently writes best-selling mathematics books while continuing to perform in television and film. Similarly, rock star Brian May took some thirty years off from a doctoral program in astrophysics to perform as singer, songwriter, and guitarist for the band Queen. Now considered a leading authority on cosmic dust, he has recently collaborated with NASA on the New Horizons probe into the outer reaches of our solar system.

With combinatorial creativity in mind, the question is not whether McKellar and May prove equally productive in all their endeavors, but to what extent their “expertise” in breadth speaks to the transfer of ideas, techniques, and/or processes from one field to another within their networks of enterprise. Consider the Nobel Prizewinning economist Herbert Simon, who made fundamental contributions to political science, philosophy, cognitive science, and psychology while also practicing hobbies including chess, piano playing, musical composition, drawing and painting. He was highly aware of the mutual reinforcements of avocation and vocation: “I can rationalize any activity I engage in as simply another form of research on cognition ...” he once said. “I can always view my hobbies as part of my research” (cited in [Frantz and Marsh, 2016](#), pp. 1–2). Indeed, it was Simon, in collaboration with Chase (1973), who formulated the well-known “ten-year rule” for mastering a new subject by studying how long it took him to learn chess. Although never a world-class chess player, Simon acquired enough *savoir-faire* in the game to connect it usefully to his professional research on decision-making. In Simon’s hands, creative polymathy led to the integration, not just of disparate interests, but of disparate areas of knowledge.

Differential Rates of Polymathy and Patterns of Creative Achievement

General considerations suggest that polymathy is not only associated with, but relatively common among the eminent. [Van’t Hoff \(1878\)](#) found that 26% of the scientists he studied displayed artistic inclinations. [Claparède and Flournoy \(1902/1904\)](#) found that 52% of the mathematicians they studied pursued a musical avocation. Taking a much longer view over 2000 years of Western history, [Gray’s 1966](#) study of 2400 eminent individuals reported that 19% made significant contributions to more than one discipline, even though scientific or technological fields of interest were omitted from review. [Cassandro’s 1998](#) study of 2102 creative

geniuses over the same time period found that 24% were eminent in more than one field (e.g., science and literature); another 15% were eminent in related disciplines (e.g. painting and sculpting or literature and drama).

Certain limitations of these studies—disregard of avocational activity or preferential attention to one or another field of knowledge and lack of rigorous controls—suggests that their overall results may very well under-estimate expressions of polymathy among the elite. As a corrective, Root-Bernstein and collaborators have taken a survey approach to documenting concurrent vocational and avocational engagement among both average and eminent groups of professionals. Self-reports of avocations and hobbies are correlated with vocational achievement measures such as numbers of papers published, patents granted, companies founded, citation totals, membership in a national academy, or the award of a Nobel Prize. The data are then compared with rates of avocational participation reported in census data or in windfall surveys of open enrollment groups, such as the 1937 survey of its membership by Sigma Xi, The Scientific Research Society.

In this manner, Root-Bernstein and collaborators have found that the eminent scientist typically engages in one or more adult arts, crafts, or performance-related avocations, whereas only one in three average scientists do so. Fifteen to twenty-five percent of all scientists have an adult music avocation, while 10%–15% have an adult photography avocation. Grouped by themselves, however, eminent scientists are 15 to 25 *times* more likely than average scientists or the average US citizen to have adult avocations involving visual and plastic arts, drama, creative writing, or crafts such as woodworking and metalworking (Root-Bernstein & Root-Bernstein, 2004; Root-Bernstein et al., 2008). Root-Bernstein et al. (2019a; 2019b), as well as Niemi (2015), observe that these types of correlations also apply more broadly to science, technology, engineering, mathematics and medical (STEMM) professionals most likely to produce patents, found new companies, or produce high impact scientific papers. Moreover, Root-Bernstein et al. (1993) found in one longitudinal study group that scientists winning the highest honors and having the highest impact measures (12 of 38 individuals, or 31%) worked across multiple scientific disciplines; in comparison, less successful scientists in the same group remained within the discipline in which they obtained formal training.

The present authors have undertaken a broader, as yet unpublished, study of Nobel laureates in literature, economics, and peace that extends comparison to additional professions beyond science and to general population controls from across the globe. By and large, the incidence of polymathy among these additional groups of eminent creators reflects that found among elite STEM professionals. Fifty percent or more of literature, peace, or economics laureates have demonstrated interests in two or more fields of endeavor. Sizeable proportions, ranging from 14.5% of Peace Nobels to 30% of Literature Nobels, engage in three or more fields. Despite common polymathic inclination, however, each group of laureates tends to favor different patterns of interest integration. Forty-four percent of laureates in literature, for instance, favor polymathic pursuit in the arts, whereas only 18% of economic laureates and 22% of peace laureates do. The latter two groups appear to prefer intellectual avocations in the humanities and social sciences or, indeed, the sciences. Dual or serial vocations are not uncommon. Gao Xingjian, literature laureate, has made his reputation as both writer and painter; Maurice Allais, economics laureate, also won acclaim as a physicist; Fridtjof Nansen, peace laureate, combined outstanding achievements as an athlete, scientist, explorer and diplomat.

In sum, Root-Bernstein and collaborators confirm van't Hoff's (1878), Claparède and Flournoy's (1902/1904) and Cassandro's (1998) finding that many eminent individuals become well-recognized in two or more related disciplines. Polymathy is highly noticeable among the elite in a range of fields; it is also reasonably common among working professionals, at least in the sciences and engineering. Root-Bernstein et al. (2013) document that about 60% of the STEM professionals they studied can, when asked, articulate specific ways in which they integrate diverse avocations with vocation. Over 80% argue that such integration is valuable to professional training. In combination with qualitative statements made by the likes of Herbert Simon, it becomes clear that polymaths generally recognize the purposeful choice and integration of multiple interests as key to their creativity.

Types of Polymathy

As must by now be clear, polymathy comes in different shapes and sizes. Burke (2010) has proposed four qualitative types of polymaths distinguishable by intellectual breadth and practice within and across disciplines.

1. **Passive polymaths**, who are broadly educated or widely read in many disciplines but actively engage in none, or work in only one. An example of a passive polymath would be the individual mentioned above who had earned twenty-three master's degrees in as many subjects, to no creative purpose.
2. **Limited polymaths**, whose activities cluster around closely related disciplines. Mozart and Picasso represent the type. Both stayed within well-defined fields of endeavor, yet explored every aspect, material, and technique of the music or art of their day, masterfully integrating diverse themes and methods and inventing new forms. As their examples make clear, a limited polymath can be extraordinarily creative.
3. **Serial polymaths**, who forge reputations in multiple disciplines one after another, often across fields. Gordon Parks exemplifies the serial polymath, one who broke through artistic silos as well as color barriers in 20th century America, a public success in all his ventures. He originally made his reputation as a fashion photographer and a documentary photojournalist before turning to poetry, autobiographical fiction, script writing, filmmaking, music composition and, finally, painting.
4. **Proper polymaths**, who make recognized contributions to several disciplines and/or fields simultaneously. Leonardo da Vinci remains the archetype, although modern exemplars such as MIT's Erik Demaine, a mathematical prodigy turned computer innovator, ground-breaking origami artist, and glass sculptor, reminds us, along with Herbert Simon, that such polymaths can still be found today.

Araki (2015) proposes alternative terminology, using “philosophical” rather than passive, “pragmatic” rather than limited, “ideal” rather than proper to describe polymathic types commensurate with Burke’s. Root-Bernstein and Root-Bernstein (2011) propose an alternative, developmental typology focusing on the evolution of polymathic practice over a lifetime. The six categories of developmental polymathy generally expand on Burke’s last three (those Araki terms “experiential” forms), leaving aside passive (philosophical) interests as non-creative. The limited (pragmatic) polymath, for example, may serve as an umbrella category for the following two developmental types:

1. **Early specialization followed by mature specialization.** In this instance, the essential training and work of the individual remains within a single field, but over time, the individual explores more of that field in increasing breadth and depth, integrating disparate elements within the discipline in new ways. Once again, Mozart and Picasso represent individuals specializing early and late. Another good exemplar is Paul Erdős, one of the most prolific mathematicians of the past century. Erdős contributed to virtually every type of existing mathematics, while also inventing several new sub-disciplines within the field.
2. **Early breadth followed by mature specialization.** Composer Elliot Carter exemplifies this developmental type, having obtained his undergraduate degree in English while simultaneously studying music and mathematics and then teaching the latter two subjects, as well as physics and Greek literature, at the college level. As his music career blossomed, he turned full-time to music composition. Notably, many elements of Carter’s mathematical and literary training are evident in his later music, suggesting that at least some of his creativity involved a continuing integration of his early diversified training.

The next two categories expand developmentally on Burke’s concept of serial polymathy:

3. **Early specialization followed by serial mature foci.** Former National Institutes of Health Director Harold Varmus exemplifies the type. An English major in college and a university newspaper editor, Varmus discovered an interest in science as a college senior and enrolled in medical school. Eventually he switched to biomedical research and, sometime after earning a Nobel Prize, he became a highly successful administrator.
4. **Early breadth followed by serial mature foci.** Roger Guillemin, devoted in his early years to drawing, painting, music, literature, and the sciences, fits this type. Choosing specialized training as a physician, he later turned to biomedical research and, like Varmus, won a Nobel Prize. Because of his early and continued interest in painting, however, he recognized the artistic potential of computer drug design programs used for his research. Eventually he retired from scientific research to become a full-time artist recognized as one of the founders of electronic art.

The final two developmental categories expand on Burke’s concept of proper (ideal) polymathy:

5. **Early specialization followed by mature breadth.** Sometimes creative individuals are recognized and groomed early for particular talent but find the time and inclination to branch out after they have established reputations in that primary field. Richard Feynman capitalized on his mathematical ability to become one of the youngest Nobel laureates in physics, a field in which he produced more highly cited papers in a broader range of topics than anyone ever before. As he reached middle age, however, he began steadily broadening his interests within and beyond science to include music (he played bongo drums at a semi-professional level), painting, computer sciences, nanotechnology (a field whose goals he defined), writing and many other scientific disciplines as well.
6. **Early breadth followed by continuous mature breadth.** One of the best exemplars of this type is Sofia Kovalevskaya, a late 19th-century Russian mathematician also recognized by her early twenties as one of the most significant poets and playwrights of her time. Likewise, the prolific African American inventor George Washington Carver was also a painter and a scientific popularizer throughout his life.

Creative Polymathy and the Ten-Year Rule

Whether classified by qualitative or developmental type, much about the creative polymath remains elusive, including why people adopt a wide-ranging approach to developing their talents in the first place. Many consider the polymathic strategy inherently difficult, especially when measured in creative impact on more than one discipline or field. Not only does it take some ten years, or 10,000 hours (on average), to master a discipline sufficiently to contribute to the field, it may take an additional ten years, so the argument goes, to contribute something truly creative (Kaufman and Kaufman, 2007).

These observations may be well established, yet they do not appear to pertain to creative polymaths, some of whom have contributed professionally to a wide range of disciplines in very short periods of time. Darwin is one example. His integration of some ten disciplines into the theory of evolution by natural selection—certainly one of the most creative scientific achievements of all time—should have taken more than a century to accomplish if the ten-year rule were inviolable, yet he managed it in thirty. Simonton and Cassandro (2010) point to Blaise Pascal as another individual for whom the ten-year rule seems inappropriate. Pascal died at the age of 39, yet within the 20-year span of his career made significant contributions to mathematics, physics, technology, philosophy, religion, and literature.

Clearly the 10-year rule can be broken. The question is how? Prodigies, by definition, master disciplines much faster and more efficiently than the average individual; polymaths appear to do the same, though they may not display obvious prodigiousness. Rather, polymaths appear to shorten their time to mastery using highly effective learning strategies. In *The Art of Learning*

(2007), the chess prodigy Josh Waitzkin details how he consciously adapted and transferred training techniques from chess to T'ai Chi Ch'üan, a competitive martial art, thus proving himself a serial, specializing polymath. Waitzkin won the U. S. Junior Chess Championship at age sixteen, after ten years of training. He won the world championship in T'ai Chi Ch'üan at age nineteen, after just three.

Yet another learning strategy works to abrogate the ten-year rule—ironically enough, the master game plan of Herbert Simon himself. Simon cautioned that “the ‘Renaissance Mind’ is not broader than other intelligent minds, but happens to cover a narrow swathe across the multi-dimensional space of knowledge ...” (Frantz and Marsh, 2016, 1–2). He himself specialized in on the problem of decision-making wherever it occurred, rather than specializing in a discipline or field. “What I am a monomaniac about,” he acknowledged, “is decision-making” (Frantz and Marsh, 2016). The creative polymath, his example suggests, does not so much master multiple disciplines as attend to specific sets of information, principles, or processes needed to address concerns across disciplinary boundaries. Polymaths are adept at a “take-what-you-need” strategy of learning instead of a “master-the-entire-field-first” approach.

Nurturing Creative Polymathy

If strategies of learning can enhance polymathic mastery and attendant creativity, are creative polymaths born or made? The answer may well be yes to both. In their review of existing neurobiological studies, Zeidán-Chuliá and Argou-Cardozo (2018) found that cognitive functions associated with acquiring and integrating diverse types of learning are under the direct control of specific genes—and therefore are inheritable traits. The evidence also indicates that these traits are susceptible to modification and augmentation by means of experience and education. Thus, Zeidán-Chuliá and Argou-Cardozo contend that polymathy is likely to result from a combination of genetic and environmental factors. In her qualitative study of thirteen contemporary polymaths, Cotallessa (2018) argued similarly that they were “born,” in that they displayed unusually broad interests and abilities from a very young age. They were also “made,” since most benefitted from familial or institutional support of their diverse talents. As Cotallessa concluded, “Polymathy develops due to a combination of nature and nurture, and polymathy is maintained in adulthood by a willingness to continue to work to improve oneself through self-directed learning” (2018, p. 1).

Today's specialized education rarely supports the polymath's need for multi-disciplinary training. For this reason, if no other, Zeidán-Chuliá and Argou-Cardozo (2018) warn, society may be hemorrhaging polymathic talent. Certainly, as Araki (2018) and others point out, in the absence of social and institutional support polymaths face unusual obstacles, not least professional marginalization. “To be a polymath,” Cotallessa (2018) has observed, “one must accept not fitting in the typical box and perhaps even embodying apparent contradictions.” Consider the case of Silas Weir Mitchell. A practicing physician and bench scientist who founded American neurology with fundamental contributions to toxicology, pharmacology, and psychiatry, Mitchell also produced a series of best-selling historical novels considered comparable to those of Thackeray and Hawthorne, giving rise to regular accusations of charlatany from those who doubted the clinical acumen of a doctor who spent so much time writing fiction.

Despite time and energy lost to the professional drawbacks, a case can be made that creative polymathy depends on outsider experience of some kind. Regarding Nobel laureates, Hollingsworth (2007) surmised that marginal status in terms of cultural tradition, religion or language may have habituated many individuals who eventually reached the top of their professions to high degrees of cognitive dissonance and complexity—two often-identified characteristics of creative thinking. The same habituation may well be true of polymaths negotiating ambivalent professional status—at least in terms of willingness to adopt adversarial and/or innovative viewpoints or to embark on transdisciplinary syntheses. Marginalized as a woman from a career in science, Beatrix Potter was no stranger to contrarian thinking when it came to her amateur mycological studies. Subsequently funneling her idiosyncratic training as a naturalist into her picture book writing and illustrating, she made outsized contributions to children's books in no small part by rethinking fictional conceptions of nature and animal nature.

It seems worth noting at this point that different types of polymaths appear to accommodate outsider status in different ways. If proper polymaths such as Weir Mitchell get criticized for pursuing disparate fields simultaneously, serial and limited polymaths rarely do. No one attacks Roger Guillemin for becoming a professional artist after winning a Nobel Prize in Physiology or Medicine and retiring from science. No one suggests that Picasso ought not to have drawn upon so many artistic cultures, nor explored so many media and materials within the visual and plastic arts. Breadth of interest may also be masked, as in the case of individuals like the philologist and secret fantasy writer J.R.R. Tolkien, by keeping avocations hidden from professional colleagues. That the polymathic path taken by any one individual may reflect personal and professional tradeoffs of many kinds begs further investigation, particularly with reference to creative outcome.

Whatever the role of marginal status, if the link between creativity and polymathy is as strong as many investigators make out, then modification of educational and workplace institutions systems in support of creative polymaths may be of great benefit to society at large. Universities, both as educational institutions and employers, often tout the creative benefits of transdisciplinarity, but are organized in disciplinary silos that militate against it. Historically, many individuals who have succeeded at transdisciplinary projects have done so with minimal or unusual institutional support. One could argue that Darwin succeeded as a polymath only because he was independently wealthy, insulated from institutional constraints. Einstein did his breakthrough work in physics while earning a living from non-professional work as a patent examiner, a common economic strategy among

creative artists, writers and performers. Can most proper or later-breadth polymaths succeed without institutions that support such freedom? Can universities and other institutions alter their organizations to be more integrative in support of such polymaths? This, too, is an area of great importance for future research.

The Future of Polymathy Studies

Whether one considers historical, psychological, social, or economic aspects of the phenomenon, so many issues in the study of polymathy remain unresolved that it seems appropriate to conclude by way of reiterating the basic questions.

First, is polymathy necessary for creativity? Is it truly the case that the more diverse the set of disciplinary tools, methods, principles, and problems an individual masters and integrates, the greater the number of new and important contributions he or she can make?

Second, how do polymaths come by this integrative ability? Is polymathy a consequence of nature or nurture or both? To the extent that breadth of interest can be learned, what is known about how different intellectual and developmental types of polymathy respond to different educational approaches, social supports and institutional organizations? Does it matter whether polymathic ability is developed through formal, informal or self-education? How, indeed, is early polymathic potential recognized? Researchers know almost nothing about these things.

Third, where is the bar placed for polymathic achievement? Is multiple domain contribution in fact the goal of polymathy or can the integration of avocations and vocations in the service of a singular creative contribution be an equally valid outcome? Are Picassos and Mozarts working within one domain actually doing the same thing as Helmholtzes and Simons working across several?

Fourth, are only certain people endowed with broad creative capacity or does everyone have the potential to be polymathic and, through polymathy, to achieve some degree of creativity? Can the creative potential of the general population be increased by fostering polymathic studies? Can current educational institutions even offer the transdisciplinary niches necessary to accommodate the needs of polymaths? Or would it take a transformation in education?

Finally, what are the psycho-social concomitants of polymathy? Do polymaths frequently experience professional marginalization because they are inherently different in their cognitive approaches to learning and creating? Or does their personal experience of outsider status promote polymathic ability? Would removing educational and professional obstacles to polymathy paradoxically destroy some critical goad to the polymath's creativity or would it lead, instead, to a social flowering of a new Renaissance, one capable of ameliorating the most pressing problems of today and tomorrow? In the face of so many uncertainties, one prediction seems certain: it will take a polymathic approach to the problem of creative polymathy to find resilient answers.

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Pragmatism

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On the surface, there are few connections to be made between the well-established philosophical tradition of pragmatism and today's growing research literature on creativity besides some scattered references to pragmatist scholars who addressed, tangentially, creative expression (most famously John Dewey's seminal *Art as experience* from 1934). The pragmatist heritage in its depth, its views of the mind, of human action and society infuse past and present theories of and research on creativity. Pragmatism as a philosophical orientation has a lot to tell researchers about creativity today.

To start with, the notions of *value*, *appropriateness*, or *suitability*, which are embedded in classic definitions of this phenomenon, have clear pragmatist roots as they focus on the consequences of thinking, acting, and creating in the world. Second, the recurring idea that creativity requires some kind of *problem to solve* – vividly expressed in the creative problem-solving literature – has strong parallels in early 20th century pragmatist accounts of how thinking emerges out of encountering and dealing with obstacles. Most critically, there are the less visible yet hugely consequential debates that shaped pragmatism and continue to structure today's debates about creativity. Key among them is the concern for overcoming the Cartesian split *between* the inside and the outside, mind and body, self and others, person and environment. These dichotomies resonate strongly within creativity research with its rather strict separation between individual or personal versus social or cultural forms of creative expression (Glăveanu, 2013). The pragmatist solution for escaping such harmful divisions was to focus on practical action and its development. Nevertheless, creativity scholars haven't fully integrated this insight and used it to transform the discipline.

The entry will start with an introduction of basic pragmatist premises and principles in philosophy and psychology, including ontological commitments, the focus on action and person–environment transactions, and the status of truth and knowledge. This account is necessarily selective given the historical richness of pragmatist and neo-pragmatist approaches and the exponential growth of the literature on creativity in recent decades. Then the focus will hone in on four main aspects of creativity research that have been impacted by and/or can benefit further from adopting pragmatist standpoints: creativity definitions and pluralism; action-based theories of the creative process; creativity development as a social process; and methodologies that embrace holistic needs. The ideas presented are derived from key pragmatist thinkers, who have made clear contributions about creativity, namely John Dewey, William James, Charles Sanders Peirce, and George Herbert Mead, as well as neo-pragmatists inspired by their original work. The conclusion calls for more pragmatist theories and research into creativity by pointing to their openness, participatory basis and emancipative power.

Pragmatist Propositions

Pragmatism may be portrayed as an anti-dualistic, action- and future-oriented philosophy that is concerned with the betterment of individual and collective affairs and aims to empower individuals to live a flourishing life. Besides solving real-life problems, shared ambitions of pragmatists are to shape future purposes, actions and experiences and to challenge limiting social and cultural structures and mechanisms in order to refine everyday conditions for practitioners. The pivot of these emancipative functions is human experience, which should be freed from mechanical routines, fixed habits, repetition, inequality, externally enforced labor, and practices based on dogmatic and traditional assumptions. In exchange, pragmatists cultivate inherently joyful and satisfactory experiences, activities that stimulate human powers, such as reflection, playful imagination, initiative, and open-mindedness. All these qualities enhance *growth*, that is, the constant reorganization of experience, by expanding perspectives and reconstructing new purposes and new ways to deal with the environment (Dewey, 1916). As pointed out by Joas (1996), John Dewey's main theme was “growth, self-enhancement, creativity” (p. 138). In Dewey (1916) own words, there are no (educational) ends beyond growth, since “life is development” and “developing, growing, is life” (p. 50).

From a pragmatist position – especially John Dewey's – the world can be understood as a practical and changing world, which we only become aware of through our actions and encountered obstacles. Hence, the world is not already there when we encounter it, but its peculiarities are brought to life by the transaction (e.g., when we confront problems). The social world is in a state of constant

flux – it is unstable, unpredictable and prospective. Hence, from Dewey's perspective, all individuals' embodied, subjective reality is constantly re-created by a *transactional* relationship between their personal capacities and environmental features (Biesta and Burbules, 2003). This transactional process is "active, adaptive, and adjustive", which means that its function is to maintain the balance between our inner and outer environments (Biesta and Burbules, 2003, p. 11), and that both situations and selves are continually reconstructed by this dynamic interplay (Elkjaer and Simpson, 2011). Personal capacities are affected by external features, while situational conditions are modified by internal dispositions. Therefore, all human conducts (e.g., creative actions), qualities (e.g., creative abilities), events (e.g., creative processes) and issues (e.g., creativity-limiting practices) should be grasped (and studied) as functions of the person-environment transaction. All persons are unique, and experience the world from different angles, by bringing different histories, desires and dispositions to the transaction (Biesta and Burbules, 2003). Hence, pragmatism implies that a person's socially embedded reality is emergent and changeable – an object is what (s)he experiences it as, at that given time and place. Who we are, how we perceive things and what we do in given situations depend on our past, present and projected relationships with the social, cultural, and physical environment. Considering this plastic worldview, there are multiple realities. This can both be a resource for the collaborative creative process (i.e., visiting each other's perspectives to get new ideas) and personally creative growth.

In the pragmatist tradition, truth is a subjective, mutable, situated and temporary feature that depends on the person-environment transaction. Pragmatists cannot talk of truth without referring to actual things, practices, or experiences. Like all other pragmatist topics, truth is interrelated with action. For example, William James argued that truth is not built into an idea, but *happens* to it, when applying it in practice: truth cannot be defined in advance, since the value or usefulness of ideas is realized by testing in a concrete situation (Rumens and Kelemen, 2016). In this regard, it could be argued that the truth of a concept, model or approach depends also on the creativity of its user. Basically, truth is "bound up with the way in which one moment in our experience may lead us toward other moments which it will be worthwhile to have been led to" (James quoted in Brinkmann and Tanggaard, 2010, p. 244). Therefore, some events are "truer" than others, and finding out which concept, belief or proposition is truest comes down to valuating and verifying its effectiveness in resolving a given problematic situation – how well it serves as a guide for action (Rumens and Kelemen, 2016).

Hence, pragmatic truth is interdependent with the process of *inquiry*, which regards:

controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole

Dewey (1938, p. 108)

Resembling the creative process, inquiry involves sensing the need for change (e.g., being part of a situation marked by "unique doubtfulness", p. 109), conceiving the problem, observing the conditions, imagining and rationally crafting tentative solutions and the anticipated consequences of executing these corporeal operations, and then active experimental testing of their functionality in terms of efficiently resolving the disturbed situation (Dewey, 1938). Due to the transactional premise, all solutions are existential and temporal. We cannot be sure what happens when doing something (as the situation changes, the properties of truth also change), but only active and "experimental operations" (p. 121) – not reasoning alone – can modify the environmental conditions to re-establish transactional balance. Thus, Dewey (1938) understood truths, as *warranted assertions*, implying that (conceptual) outcomes of prior inquiries are carried on as virtuous, abstract inputs (or working hypotheses) to new inquiries, where they are tested by action or imagination, as potential "*means of attaining knowledge of something else*" (p. 122). Hence, pragmatism emphasizes the continuity of knowledge and action:

Only that [knowledge] which has been organized into our disposition so as to enable us to adapt the environment to our needs and to adapt our aims and desires to the situation in which we live is really knowledge

Dewey (1916, p. 344)

Hence, ideas, concepts, principles, etc., can only be accepted as knowledge when they are used purposefully to modify the environment. Knowledge is *used* in making sense of what is occurring in the moment and what should be done in the next one. Thus, knowledge is the *act* of applying dispositions to 'straightening out a perplexity, by perceiving the connection between ourselves and the world in which we live' (p. 344), an act that holds clear potential for creativity.

Engaging with the above premises, research does not generate new knowledge, but scientific ideas may become knowledge when applied in practice. Based on Dewey's *experimentalism*, which was his preferred name for his philosophy, theories should be treated as tools to play, think and create with in order to find prospective action possibilities, and facilitate learning, that is, "acquisition of more varied and complex predispositions to act" (Elkjaer and Simpson, 2011, p. 71). Accordingly, pragmatist studies should be evaluated based on their effectivity in inspiring and guiding the future practical affairs of communities, groups, or individuals.

For we live not in a settled and finished world, but in one which is going on, and where our main task is prospective, and where retrospect (...) is of value in the solidity, security, and fertility it affords our dealings with the future

Dewey (1916, p. 151)

Hence, endeavors in describing a world that has already passed only make sense when turned into a guide for future actions. As Dewey reminded us, the aforesaid emancipatory and utilitarian elements are central for the pragmatist conception of knowledge: Theoretical ideas should not only stimulate fresh moments in human experiences, but also have a moral character (Brinkmann and Tanggaard, 2010), that is, improve human conditions, events and purposes in a broader sense. Accordingly, pragmatists promote democratic ideals and values such as human growth, freedom, equality, diversity, tolerance, responsibility, and flourishing, as well as abilities such as problem-solving, critical thinking, communication and – as highlighted by the present entry – creativity.

Pragmatists tend to consider individuals as generative, autonomous agents, who are driven by a (creative) capacity and need for shaping and interfering with their physical and social environments. The possibility and tendency to do so depend on the transactional components, namely the quality of the social structures and generative capacities at play in the given situation (Rasmussen et al., 2017). From childhood, our activities are marked by an active exploration and redefinition of our situation (that is, creativity), but as life goes on, many people become inclined to adjust their actions to the environment (i.e., habituation) rather than modifying the environment to their own desires, interests and activities. For example, conforming traditions, dictating instructions, and the fixity of habits may neglect and impair creative qualities. As Dewey (1916) argued, people's original bodily *plasticity* – the natural ability to vary our actions until discovering an efficient and appropriate solution – is forsaken by environments that are not ensuring 'the full use of intelligence in the process of forming habits' (p. 49), meaning that they cannot engage in undertakings requiring conscious deliberation, reflection, decisions, and creative actions.

Demonstrating how these ontological and epistemological commitments of pragmatism underpin and inform the research process, the following sections deal with four key issues within creativity research: 1) definition, 2) nature, 3) development, and 4) measurement.

Creativity Definitions

Committing to the transactional premise and the idea that we as unique individuals operate experimentally in a social, unstable and changeable world, pragmatism is marked by welcoming *pluralism*, meaning that pragmatists celebrate and encourage a multiplicity of "values, experiences, meanings, perspectives, and methodologies" (Rumens and Kelemen, 2016, p. 12). In William James' view, the world is full of indeterminate possibilities. There are numerous ways of engaging with, expressing in, describing, interpreting, and transforming the world.

Serving the present purpose, pragmatism offers a "pluralism of knowledge" by recognizing the validity of a variety of individual and collective interests, perspectives and forms of knowledge (Cornish and Gillespie, 2009). Pragmatism also fosters what can be called a "pluralism of experience". For James, *experience* continually envelops external objects, their relation to each other and to our purposes, which enable us to handle and shape the environment in meaningful ways (Rumens and Kelemen, 2016). This continuity enables us to use past experiences and present perceptions as instruments to anticipate and handle future experiences. Such a future-oriented process allows us to act in new ways and to evaluate the effectiveness of these acts. Similarly, for Dewey, experience regards the continuous and dynamic partaking in, and transactional adjustments to, the physical and cultural environment. When we experience something, we are acting on things; we are doing something and are undergoing the consequences of these doings (Dewey, 1916).

Reflecting the notion of truth, pluralism does not mean that all concepts, beliefs or definitions are equally beneficial – some ways of engaging with the world are better than others. Although acknowledging diverse, competing forms of knowledge, pragmatists would explore and conceive

- a) origins of opinions;
- b) interplay between beliefs, context, and history;
- c) sensible actions a definition gives rise to;
- d) potential practical consequences of applying particular approaches.

Further, pragmatists question whose and which interests are addressed, disregarded or undermined (Cornish and Gillespie, 2009) in the given situation. As outlined above, such queries pursue a democratic ethics to avoid adherence to authorities, customs, and impulses. For Dewey, democratic communities should improve the life for everyone, rather than for the selected few.

Pragmatic pluralism was central to our recent study in a Danish soccer talent development environment (Rasmussen et al., 2019) where qualitatively different conceptions of creativity were explored. Interviews with coaches and observations of training activities formed the experiential underpinning that led to a conceptual landscape covering 15 metaphors (e.g., *transgression*, *magic*, *invention*, *surgicity* and *choreography*), embodying a diversity of meanings, values, and applications of creativity. Although embracing these fluid and plural ways to approach creativity, the metaphors were contrasted in terms of their appropriateness in serving all players. Among others, this showed that coaches disagree which players (and positions) are creative, why creativity is important and how it is nurtured (each coach applied a unique selection of metaphors). For example, some supposed that pre- and post-game creativities (e.g., *exploration*) were vital to develop as a player and enjoy the game (i.e., aiding everyone); others believed that in-game creativities (i.e., *deception*) enhanced the likelihood of being victorious (i.e., spotlighting offensive players). Also, application of growth-related variants stressed originality (e.g., letting players decide; try novelties), but the game-decisive ones accentuated appropriateness (e.g., equipping players with useful tools; do the most effective). This study may expand, in a pragmatist manner, the experiences of actors in sports, and entail more nuanced dialogues about sporting creativity. Given our uniqueness, everyone can pass distinctive things to others, if able to turn experiences into ideas (Joas, 1996).

Pragmatist pluralism entails that there are many ways to conceptualize the world and its parts. No matter whether they are “humble guesses or dignified theories” (p. 160), definitions do not offer factual ways to conceive the world (Dewey, 1916). Offering varied accounts of or perspectives on the world; definitions are “forecasts calculated to influence responses” (p. 178). By means of dialogue and experience, a single approach may be recognized as superior in achieving particular ends, but there is no unconditional “best” approach (Cornish and Gillespie, 2009; Rumens and Kelemen, 2016). Finally, pragmatism encourages students and researchers to accept one’s shortcomings, be open to otherness, and avoid fixity of doing or thinking (e.g., preferred definitions). Hence, when examining rival positions or assumptions, pragmatists should aim to seek common ground, understand the differences, and grasp the other positions in the strongest way possible.

The Nature of Creativity

Pragmatist scholarship has a unique contribution to make to our understanding of the nature of creativity itself. This is the case given that pragmatists have been keen to engage with a dichotomy that is central for the very setup of creativity studies – the dichotomy between “inside” and “outside” of the creative person. Since early on, the scientific study of creativity has focused on intra-psychological correlates of creative expression. For example, J. P. Guilford, in his celebrated address to the American Psychological Association, encouraged fellow psychologists to research and to educate what he called the “creative personality.” In the decades that followed, researchers explored in-depth the “inner” attributes of creators including intelligence, motivation, thinking styles and thinking processes. Meanwhile, since the 1980s, a sustained critique of this focus on isolated individuals emerged in the form of Csikszentmihalyi’s systemic and Glăveanu’s distributed models. The latter are particularly inspired by pragmatist ideas in that they don’t call for a focus on elements “outside” the creative individual but aim to do away with the inside–outside dichotomy altogether. In other words, they advocate for the study of *creative action* (doing or making) not as opposed to but as integrating creative thinking.

This ethos to transcend the Cartesian split between person and environment has been foundational for pragmatists. In 1896, John Dewey wrote a seminal paper criticizing the traditional conception of the *reflex arc* in the psychology of the time. In particular, he questioned the artificial separation, in the reflex arc, between stimulus (external) and perception (internal), as well as that between the sensorial (cognitive) and the motor or response system (bodily). Instead of a disjointed mechanism, Dewey proposed the notion of *coordination* in order to bring together the sensory stimulus, the central processing, and the motor discharge. Instead of artificial separations, he proposed a holistic and dynamic perspective on the whole process of “sensation-followed-by-idea-followed-by-movement” (Dewey, 1896, p. 358). These *action-perception loops*, as they would be later interpreted by cognitive science, are crucial not only for functions as basic as perception, but also for phenomena as complex as creativity. In fact, Dewey went on to propose a similar view of interdependence and coordination between action and perception within the creative act in his seminal work *Art as Experience* (1934). He described the process as follows:

Antecedent subject-matter is not instantaneously changed into the matter of a work of art in the mind of an artist. It is a developing process. As we have already seen, the artist finds where he is going because of what he has previously done; that is, the original excitation and stir of some contact with the world undergo successive transformation. The state of the matter he has arrived at sets up demands to be fulfilled and it institutes a framework that limits further operations (p. 116).

For Dewey, therefore, artistic creativity is best described as a developing form of acting or, better said, inter-acting in and with the world. This action is made up of a cyclical relation between *doing and undergoing* or acting on the environment and being acted upon, in return, by the effects of one’s doing. This basic process that, for Dewey, characterizes human experience, can be applied beyond art to many other domains of creative production. In fact, as we argue here, it captures something essential about the nature of creativity when theorized in terms of action: the fact that it bridges the external and the internal, self and others, person and context. Creative thinking, just like the sensation within the reflex arc, is not a separate component of creativity – it “extends” into the world through the creator’s doing and it is enriched by its undergoing (similar to Piaget’s notions of assimilation and accommodation).

But isn’t the cycle of doing and undergoing broader than even creativity? Doesn’t it capture something essential about human action – and human life – in general? Joas and Kilpinen (2006), building on pragmatist accounts, believe so and, because of this, made the strong claim that “creativity constitutes human action in its entirety” (p. 323). For them, we should not be talking about creative individuals or creative products, the only entity that can have this attribute is human activity. And, for the most part, this activity is *necessarily creative*, to a smaller or greater extent. This is due to the fact that there is no separation, again, to be upheld between thought and action: we think with and through the means of action and we act in ways that are both guided by and guide our thinking. The potential for novelty, improvisation, and emergence is thus ever-present. In this way, from a pragmatist standpoint, a study of the nature of creativity leads us to a deeper understanding of what makes us human and not vice versa.

The Development of Creativity

If creativity is intimately related to human nature, then their “origins” should also be similar. And, indeed, a pragmatist study of the emergence of a *human self* reveals a new facet of their deep interconnection. In order to grasp it, we need to turn to the work of

another well-known pragmatist, George Herbert Mead. The central question in Mead's philosophy and social psychology is related to the construction of the self. His answer to this question points us to the birth of *reflexivity*.

The self emerges at the moment in which it becomes capable to *take the perspective* (role or attitude, in Mead's initial terminology) of the other upon the self. This process requires both a form of decentration from one's own position and perspective in the world and a bridge toward the subjectivity of another person, understood as similar to one's own. The first implication of this view is that the mind and the self are a "not initially there at birth, but arise in the process of social experience and activity" (Mead, 1934, p. 255). Second, this dynamic has deep consequences of human *agency* and, by extension, for creativity. The social act of taking the perspective of another upon oneself not only marks authentic forms of intersubjectivity, but also makes the self's relation to the world – including oneself – more flexible. By becoming capable to understand the world and act within it (for the connection between thinking and action revisit the previous section) from a different position, the person expands his or her own horizon of *possibility*. Instead of being "trapped" within singular and egocentric perspectives (which tend to dominate in the case of animals and new-borns), a social self can entertain multiple perspectives and, in doing so, reflect and become agentic in relation to them. In the end, the same space of multiple perspectives and reflective dialogues between them is at the heart of creativity (see the perspectival model; Glăveanu, 2015). From a pragmatist standpoint we can argue, thus, that creativity and the self are twin-born, developmentally, in the act of perspective taking.

This last idea has been developed by Gillespie and Martin, two neo-Meadean scholars, into what they call Position Exchange Theory (PET):

The first assumption is that society comprises a multitude of social positions, many of which are interdependent (Durkheim, 1893). Social positions only exist in social situations. They are socio-institutional locations within our social structure from which people speak and act, constituted by rights, responsibilities, and situational demands. (...) The second assumption is that social positions constitute perspectives, that is, psychological and embodied orientations, interests, and even world views. (...) The third assumption is that people move between social positions

Gillespie and Martin (2014, p. 74)

Taken together, these assumptions are highly illuminating for the development of creativity. It is because we get to occupy different positions in the world, initially through pretend play, that we get, in an imaginative and embodied manner, to experience the world from their different perspectives. The possibility of moving between positions, which is at the basis of social interaction, facilitates exchanging perspective and, in the process, integrating and multiplying them. The latter are creative processes or, at the very least, processes that hold promise for creativity. In this manner, pragmatically, creativity emerges out of self-building acts such as *position exchange and perspective taking* and, in turn, becomes the dominant characteristic of the newly created self. Decentering from one's own position and perspective are not only crucial developmental achievements for the person according to Piaget, but also an essential condition for creative expression. As such, creating comes to bridge not only the internal and the external, as mentioned before, but also the dichotomy between self and other. If theoretically this degree of complexity can be easily explained using a pragmatist vocabulary, it is intrinsically difficult to study creativity in the same holistic and dynamic manner at an empirical level. This leads us to a last challenge: the methodological one.

Creativity and Methodology

As a non-foundationalist position, pragmatism rejects fixed, objective methodological criteria. No single design, method, or theory is intrinsically best for pragmatists, but some are more useful in serving particular research purposes and interests. Still, the pragmatist principles may guide which kinds of questions are asked and how they can be answered. Reminiscent to the standard definition of creativity, pragmatism urges scholars to generate original and useful (as well as more complex) ideas, purposes, processes and ends – for people, scholars and societies.

Evocative of the spontaneous and inventive search for potential solutions during inquiry is C. S. Peirce's notion of *abduction*, which may be described as an extending and speculating approach to inquiry, where explanatory propositions, hunches and ideas are produced and explored. As the only way to form new hypotheses, Peirce believed that abduction was "a necessary, but not sufficient, condition for the advance of science" (Joas, 1996, p. 134). Contrary to the constrained and retrospective processes of induction and deduction, imagination prevails in abduction to create novel purposes and solutions and anticipate their consequences, project alternative futures, and open ways to engage with the environment that were previously tied by historical bonds (Elkjaer and Simpson, 2011).

Based on the transactional premise, pragmatists approach social practices as complex, temporal interweaving's of social agency and social situations (Elkjaer and Simpson, 2011). Since practices are inseparable from the continuity of experience, its meanings and actions are constantly moving. Engulfed by adaptations across persons and environments, Dewey (1938) suggested that scholars interested in the social world should do experimental research on human reactions, what we are influenced by, and how we change, that is, studies "on the process and from within the process" (p. 180). This calls to participative, action-oriented research, and turn attention toward temporal aspects.

As implied in "The Nature of Creativity" section, pragmatists do not understand inner and outer processes, or personal and environmental features, as discrete entities, but as mutable, inter-reliant constituents of an integrated whole. Pragmatism emphasizes

holistic, contextualized, and problem-focused approaches that address intertwined, immanent features and dynamic processes (Elkjaer and Simpson, 2011). These premises permeated our aforesaid study in the context of soccer (Rasmussen et al., under review), where the creativity conceptions were grasped as fluctuating and fragmented, cultural discourses, continuously growing out of and informing coaching practice. Forming a multifaceted, interactive, organic and flexible typology, this ecosystem of beliefs exhibits the unique complexity of creativities fostered in the specific context at that time of our study. Lacking a shared approach to creativity, the coaches made sense of the term in relation to personal experiences and soccer philosophies, local tactical principles, and general tendencies in the world of soccer. They utilized, appropriated and transformed diverse perspectives to serve heterogeneous purposes and interests. Although these findings are context-dependent, located in and bound to the transactional process of the specific inquiry, they add pragmatic value by disclosing local presumptions, routines and discrepancies regarding creativity and its promotion on the one hand, and a plurality of ideas regarding creative qualities and creative training activities on the other.

Extending the pragmatist interest in studying “what works”, how and why it does or doesn’t work (Rumens and Kelemen, 2016), Brinkmann and Tanggaard pointed out that the most exciting question for pragmatists is which kinds of actions and experiences are facilitated by a particular principle or approach. Surpassing traditional philosophies that draw attention to actors, pragmatism focuses on studying situated human actions, including both doings and sayings (what and in which way things are said or done) as well as and effective and failed actions, to grasp how individuals and groups make sense of their world. It is particularly interesting to explore how actors experience the world as meaningful in contexts where the environing conditions are (or have been) reshaped to develop creativity, e.g., by tracing actions and experiences throughout the process of re-organization. This may lead to discovering and formulating relations between personal and social qualities that facilitate creative actions and/or enhance our creative powers.

Conclusion

What can pragmatism teach us about creativity? First, that creativity is a problem of life: we all do and experience creativity in various guises and are subjected to numerous situations where we are required to act creatively. Second, that creative phenomena are plural and multifaceted, and they are both defined and expressed within everyday contexts of living. Third, that their expression is rooted in action and interaction, engaging both self and other in an act of co-constructive participation.

The pragmatist idea about the constitutive *power of knowledge* in terms of defining our possibilities and problems, and favoring of inquiry and experience as pathways to new knowledge carry a huge potential for creativity scholars desiring to develop emancipatory, anti-oppressive, as well as culture critical and inspiring research (Cornish and Gillespie, 2009). Pragmatists values scholarships that challenge assumptions and create richer futures, by offering new ways to think and act, or guiding social reform, that is, modification of environing and existential conditions so people are enabled to thrive, living their common life in a gratifying and fertile way.

Reminding ourselves of the widespread potentials of creativity in terms of enjoyment, learning, adaptation and societal progress, pragmatism offers a sound basis for doing various kinds of *creativity-developing research*. The most important legacies of the pragmatist philosophical tradition in terms of doing creativity research are to expose, enlighten and subvert creativity-limiting practices and to cultivate democratic communities of creative and critical inquirers, who are able (and free) to utilize their creative potential and handle everyday problems as they arise. On this account, the *emancipatory element* of pragmatism regards developing creativity-nurturing communities and enabling people to acquire the knowledge required to gain creative control of their own life.

Pragmatism not only have a special contribution to make to the understanding and practice of creativity, but also suggests that these should be revisited by the community of researchers for new insights into what it means to create not as isolated brains or minds, but as full human beings living in a shared socio-cultural and material world.

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Problem Finding[☆]

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What Is Problem Finding?

One major approach to the study of creativity is the examination of cognitive processes involved in creative problem solving and creative thinking. Most of the cognitive process models include problem finding or an associated construct as the first step (e.g., Dewey, 1910; Guilford, 1967; Mumford et al., 1991; Newell and Simon, 1972; Sternberg, 1986). J.P. Guilford was the first to recognize the importance of problem finding, coining the term “sensitivity to problems”. Other models have used terms such as problem definition, problem identification, problem formulation, problem generation, problem discovery, and problem construction. While specific definitions of each term vary somewhat, all have a common thread and to prevent confusion, the term problem finding will be used throughout this entry. Problem finding is viewed as an umbrella term and includes the multiple aspects delineated in the literature. Reiter-Palmon and Robinson (2009) indicated that problem finding includes multiple aspects. One includes problem anticipation and identifying problems or opportunities in the environment when they are not presented to the problem solver. The second aspect includes structuring and defining the problem in a way that provides a starting point to formulate a solution.

Other research differentiated problem finding tasks by the degree to which the problem is given to the problem solver (e.g., Reiter-Palmon and Hullsiek, 2010). This ranges from problems that are well structured and given to the problem solver (presented problems), to ill-defined problems where the problem solver identifies the problem (discovered problem), to problems that have yet to be explicitly recognized and are found or generated by the problem solver (created or generated problem). The role of problem finding is particularly important when problems are ill-defined for two reasons. One aspect of problem finding calls for identifying possible problems in the environment, many times when problems are not clearly identified, or even known. These types of problems are ill-defined by definition, as no problem is presented to the problem solver. The second aspect requires the structuring and defining of the problem. If the problem is well-defined or structured, there is no need for problem finding.

It is important to note that while problem finding is seen as the first step in creative problem solving, followed by other processes such as information search, idea generation, and idea evaluation, the creative problem solving process is not as fixed. Creative problem solving can be interpreted as more cyclical in nature. Likely as a result of difficulties encountered in later processes individuals may cycle back to earlier processes. For example, finding new information that requires the individual to think about the situation or problem in a new way may result in reformulation of the problem. Similarly, if during idea evaluation, the individual identifies that no good ideas were developed, he or she may cycle back to earlier stages – either to the idea generation phase or the problem finding phase.

The Process of Problem Finding

While most creative problem solving models include problem finding as the first process, there only a limited number of models of the problem finding process itself. Early models such as those by Dewey (1910) and Guilford (1967) provided a separation between problem recognition followed by problem definition. Basadur (1995) has suggested that both ideation and evaluation play a role in problem finding.

A more detailed process model of problem finding has been suggested by Michael Mumford et al. (1994). This model starts with attention and perception. Individuals need to attend to and perceive a gap or a problem in the environment. It seems that when

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problems are well-defined, there is no such perception, and the process of problem finding either is bypassed or occurs quickly and automatically. This first step corresponds to what appears in theoretical models as one aspect of problem finding – problem anticipation or identifying opportunities in the environment. Attention and perception of environmental cues trigger problem representations. Problem representations are knowledge structures based on past problem solving efforts and include four types of information (a) the goals and outcomes associated with the problem solving effort, (b) information required to define and solve the problem, (c) procedures and operations performed on the information in order to solve the problem, and (d) constraints and restrictions on the problem solving effort.

Problem representations are activated through environmental cues. If the problem representation has been associated with a specific cue in the past, it will be activated. More ill-defined problems and situations are likely to have more diverse and complex set of cues. In addition, ill-defined problems will likely have cues that are associated with multiple problem representations resulting in more problem representations being activated. As the problem or situation is more well-defined, structured and less complex, it is more likely that a small number, or even one, problem representation will be activated. If the problem is identical or very similar to a problem solved in the past, the problem representation associated with that problem solving effort will be activated. When only one problem representation is activated, it is likely that the problem solver quickly and automatically completes the problem finding process moving immediately to problem solving. When multiple problem representations are activated, and a single problem representation cannot be used, the problem solver must find a way to create a new problem representation that includes a mix of the elements from the activated problem representations to guide problem solving. This will likely result in a more creative way to define the problem, and therefore more creative solution.

The process described above has several important implications. First, in most situations, problem finding will occur automatically. These situations include routine problems, problems that have been encountered before and solved successfully, or problems that are similar to previously encountered problems. Active engagement in problem finding will occur only when the problem is different enough from past experiences or includes diverse information that elicits multiple problem representations. A second implication is that the problem finding process, like the creative problem solving process as a whole, includes both divergent and convergent elements. The activation of multiple problem representations, multiple ways of perceiving the problem, is a divergent process. However, the integration of the various problem representations into a new single coherent (and original) representation is a convergent process. Finally, an important implication of this model is the role that knowledge plays in the problem finding process. Activation of problem representations occurs based on the similarity of cues perceived in the environment and existing problem representations. Therefore, some knowledge is necessary for effective problem finding to take place. Further, the availability of a pool of potentially useful problem representations would be beneficial.

Importance of Problem Finding

Problem finding has been linked to creativity in a wide range of domains. The seminal study by [Getzels and Csikszentmihalyi \(1975\)](#) linked problem finding behaviors with originality and aesthetic value of paintings created by art students. More importantly, problem finding measures were also predictive of success as an artist measured 7 and 18 years later. Problem finding has also been found to predict creative accomplishments and creative problem solving in everyday problems. In addition, problem finding has been found to predict creativity above and beyond known predictors such as divergent thinking and intelligence. Research suggests that problem finding seems to be characteristic of creative individuals.

In addition, problem finding has been found to be related to creativity overall. Laboratory studies in which problem finding has been manipulated find that individuals that engage in problem finding are more likely to generate creative ideas compared to those that do not. In addition, research has shown that the quality and originality of problem restatements predict solution creativity ([Arreola and Reiter-Palmon, 2016](#)).

Factors Affecting Problem Finding

Research finds that problem finding is indeed an important process in the creative problem solving process and can influence later processes. However, it is also important to understand the factors that influence effective problem finding and therefore may have an effect on creativity. One of the most accepted finding has been that active engagement in problem finding results in increased creativity. Multiple studies, employing various methods to induce active engagement have found that active engagement in problem finding increases the creativity of the process itself and of the resulting solution. In some studies, participants were given instructions to think about the problem prior to solving it, to identify goals, or to rephrase the problem in different. Other research has induced active engagement by training the problem finding process (alone or in combination with other creativity relevant processes). Research evaluating training programs designed to improve the problem finding process finds not only improvement in this process, but also in creative problem solving in general. In addition, a meta-analysis on the effect of creativity training has found that training in problem finding resulted in improved creativity across multiple studies, and was one of the best interventions for improving creativity.

Individual differences also play a role in the problem finding process. First, several studies have found that problem finding ability was related to more original problem finding and increased creativity of the solution. Additionally, individuals who are more creative as well as experts spend more time defining the problem. The effect of expertise on problem finding however, is

not fully understood. Experts spend more time defining the problem relative to novices, and are likely to have more problem representations that can be used in defining the problem. Conversely, experts are more likely to evaluate new problems as similar to those that they have encountered in the past, resulting in the use of a dominant problem representation. On the other hand, it is possible that experts find particularly creative solutions to problems by actively identifying constraints.

In addition to problem finding ability and expertise, recent work has suggested that dialectical thinking, the ability to work with and accept contradictions is related to problem finding. Other personality variables linked to problem finding have been those that traditionally have been related to creativity in general. Variables such as openness, tolerance for ambiguity, and flexibility have all been found to be related to creative problem finding. It is not surprising that the variables that emerged as related to effective problem finding tend to be those that related to cognitive style or individual difference in processing information.

Other types of individual differences variable related to problem finding are related to motivation. Individuals who see themselves as creative, have creative self-efficacy, and self-esteem, tend to also be more likely to engage in effective problem finding. Active engagement in problem finding is an effortful and time consuming activity. It is therefore likely that only those individuals who are motivated to engage in the process will do so. While some research exists on the role of personality and motivational variables in problem finding, the literature is limited, and more work is needed.

Situational variables also exert an influence on problem finding. The type of problem or task is one variable that has been investigated. More ill-defined problems allow for more problem finding. Further, more solutions are generated to problems that are created or generated by the problem solver as opposed to a presented problem (even when it is ill-defined) When problems are generated, they may reflect the interests and concerns of the problem solver and therefore are more likely to be more involving and interesting to the problem solver, which would speak to the motivational aspects of problem finding and creativity.

Other task characteristics include the degree of consistency of information presented in the problem. More ill-defined problems tend to include more diverse cues, some of which may be inconsistent or in conflict with one another. Diverse cues or contradictory information in the problem has been linked to increased originality and creativity of the solutions, presumably based on the effect these cues and contradictions have on the diversity of the problem representations activated and the need to integrate diverse problem representations. This finding mirrors findings regarding individual differences, where dialectical thinking, has been linked to increased problem finding and creativity.

Task effects and domain effects have emerged as an area that influence various findings regarding creativity. A recent meta-analysis suggests that the relationship between problem finding and creativity is dependent on domain and measure of creativity (Abdulla et al., 2018). Specifically, problem finding was found to be a stronger predictor of creative products than divergent thinking. In addition, problem finding was found to have a stronger relationship with creativity as measured by fluency and originality for divergent thinking compared to other measures.

Finally, available time and time pressure will likely affect the problem finding process. Problem finding takes time and effort, and past research has consistently found that individuals who spend more time on this process, develop more alternatives for how the problem is viewed, and also develop more creative ideas. Because the process tends to be automatic most of the time, it is likely that time pressure will result in an automatic application of the process instead of active engagement.

Measurement of Problem Finding

One of the more difficult issues when studying problem finding is the measurement of the process. As problem finding is typically automatic, and does not have an outcome that can be evaluated, probing is necessary to observe the outcome of the problem finding process. A typical approach of evaluating problem finding involves asking participants to define the problem in multiple different ways. However, this probing is a direct manipulation of problem finding, one that is also used to induce active engagement in problem finding. It is therefore difficult, if not impossible, to study problem finding directly without also manipulating it. In order to further our understanding of the problem finding process, it would be helpful to identify a way to measure problem finding without manipulating it or creating active engagement. This will allow the study of problem finding in its natural form.

The fact that measuring problem finding requires the manipulation of problem finding also raises another important issue. How problem finding is manipulated may affect the results of the process. One popular method uses a variation of Baer's (1988) approach, in which an ill-defined problem is presented, and participants are asked to restate the problem in as many different ways as possible. This sort of manipulation induces active engagement and forces participants to think in an effortful manner about how to define the problem. In addition, this specific approach seems to be geared toward a focus on goals, which are only one element of the problem representation. It is possible that different approaches for inducing active problem finding, with a focus on other elements, such as constraints or information needed, may result in somewhat different outcomes.

Finally, the approach discussed above for eliciting information about the problem finding process presents the problem solver with an ill-defined problem. Providing the problem to be solved allows for control in the study of problem finding, as all problem solvers react to the same stimulus. However, by providing all problem solvers a problem, the focus is on one aspect of the problem finding process, that of structuring the problem. As stated, problem finding includes both the process of identifying opportunities and problems as well as defining what the problem is. When the same ill-defined problem is presented to all participants, by definition, researchers are focusing on presented problems and the process of defining the problem. Generated problems and the process of identifying problems and opportunities cannot be investigated when the same ill-defined problem is presented. Only

a handful of studies have evaluated the latter, finding increased creativity for generated problems compared to presented problems (e.g., Runco and Okuda, 1988).

Teams and Problem Finding

Teams are faced with many opportunities to engage in problem solving, including creative problem solving. Organizations use teams to address the need for having multiple stakeholders (such as members of different departments) involved in decision making, or when problems are too complex for one individual to solve. Research on cognitive processes at the team level, whether they relate to creativity or more routine problem solving efforts, is sparse. The only area that has received much attention is that of brainstorming. However, both earlier processes to idea generation such problem finding, and later processes such as idea evaluation have received some attention. Extant research on problem solving and teams suggest that teams engage in cycles of experimentation. These cycles involve sequences of activities performed by the group that lead to insights on requirements and constraints. This process resembles the problem construction process found when individuals solve creative problems.

When individuals work in a team to solve problems, problem finding must be evaluated from two perspectives. Each individual within the team will engage in problem finding and the problem may be defined differently by each individual. Problem finding and defining of the problem is a result of the problem representations elicited by the cues in the environment. Both attention to these cues as well as the problem representations available to the individual will be based on past experiences. Since past experience will differ from one person to another, it is reasonable to expect that when problems are ill-defined, individuals within a team will view the problems in different ways. Past research on team problem solving and decision making suggests that teams that are homogeneous (based on gender, expertise, and the like) are more likely to experience difficulty reaching a consensus on a solution and difficulty communicating effectively.

The availability of multiple problem representations at the team level, just like at the individual level, may lead to integration of these problem representations in new and creative ways, leading to a new problem representation and more creative solutions. However, as individuals typically engage in the problem finding process automatically, further, they may not be aware that other members of the team may define the problem in a different way. This may lead to misunderstanding and difficulty in communication that can be found in heterogeneous teams. Further, it is less likely that individuals will discuss the problem finding process or how each person defines the problem. Teams typically focus on the solution that is needed, and team members assume that other team members view the problem in a similar fashion. Disagreements about solutions may often be traced back to lack of agreement on how the problem is defined or the elements of the problem, such as differences in goals, restrictions, or information available or needed. Presumably, a collective problem construction process alleviates tensions and disagreements that may arise from the differing representations. Teams that engage in problem construction have been found to produce more original ideas than teams that do not engage in the process. Moreover, team problem construction facilitates social processes in addition to team creativity. Groups that construct and find problems together experience less conflict and report higher levels of satisfactions than groups that do not engage in a problem construction process.

On a larger, organizational scale, differences in problem representation also appear to affect how organizational groups construct problems. The dissimilarity of representations between groups stems from differing frames of interpretation. Often, collections of groups within an organization may hold distinct perspectives from each other. Research has shown that departments within a company draw from differing frames to solve problems related common organizational goals. As a result, these groups construct these problems differently. Furthermore, departments within an organization are often unaware that they have unique approaches to achieving common goals. Paralleling what occurs in team problem solving, disagreements and misunderstandings arise between departments. Further research is needed to determine whether a shared problem construction process would produce benefits at the organizational level.

While the last decade has seen an increase in empirical work on this topic and more is known today about problem finding, there are still many unknowns. Empirical research is needed in areas of the different types of problems and problem finding (such as problem identification vs. problem definition), measurement of problem finding, individual differences and situational variables that influence problem finding, and the process of problem finding in teams.

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Prodigies

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Definition of Prodigy and Conceptual Distinctions

Stories about children with extraordinary performance levels have always captivated the scientific and the public interest. Children who show high-level performance in highly demanding fields before the end of primary school (or before the age of 10) are known as prodigies. Some of the most known examples of prodigy children come from the domain of music. Mozart, Chopin, and Liszt exhibited remarkable musical performance skills from very young ages. There are also examples of children with exceptional performances in mathematics and chess. In domains such as the visual arts, science or literature, remarkable achievements are found only in older ages. Albert Einstein or Charles Darwin are known as geniuses rather than prodigies because science is much more complex and requires a longer period to develop the expertise that is required for notable achievement.

“Prodigy” has overlapping characteristics with other phenomena such as talent, giftedness, and expertise. Ellen Winner, who has written extensively about talent, giftedness and prodigy, conceives of these concepts on a continuum with no strict delimitation between them. Nevertheless, these terms are often used interchangeably in a misleading way. It is important to notice that the term prodigy designates a child that is both talented and gifted, and who demonstrates expertise in a specific field. However, a talented or gifted child is not necessarily a prodigy. Nor is child prodigy a prerequisite to obtaining adult expertise.

There are far more studies on giftedness than on prodigy, most likely due to the fact that prodigies constitute a very small sample of the population and they are very young.

In order to better differentiate among the concepts provided above, one should keep in mind that: 1. A prodigy is a young child (usually below the age of 10) who exhibits expertise at the level of performance in a given domain; 2. A gifted person, both child and adult, has the potential to have superior performance but does not necessarily achieve it (as prodigy children do); 3. An expert has high performance in a domain, which can be achieved by practice alone.

The chapter continues with current explanations of the prodigy phenomenon, and then with the analysis of its relationship with creativity. We will end with some open questions that are likely to spur further research in this fascinating area.

Going Beyond Descriptive Explanations of Prodigy and Heading Towards Mechanisms

Most of what we know about prodigy comes from descriptive and observational reports, focused mainly on identifying the characteristics and traits of prodigies. Currently, there is no explanatory model of the phenomenon. Some of the outstanding questions to answer are: What are the mechanisms behind their accelerated learning? To what extent is the strong motivation of prodigies a learned characteristic or a biological predisposition? Below we will address the core ideas for some of the most important approaches to the study of prodigy: developmental psychology, genetics, expertise research and neurobiology.

Developmental Explanations

Some authors argue that child prodigy is a result of a very accelerated development. In her cognitive-developmental theory, Shavinina (2010) argued that the underlying mechanism of the prodigy phenomenon consists in the sensitive periods and unique cognitive experiences that prodigies develop. In other words, child prodigies have a special age sensitivity that represents a “very selective responsiveness ... to everything what is going on around him or her” (Shavinina, 2010, p.33). Shavinina differentiates between cognitive sensitivity (i.e., to new information), emotional sensitivity (i.e., to the inner world), and social sensitivity (i.e., intersection with one another). In her approach, sensitive periods are the age periods in which the child has heightened

sensitivity. In case of prodigy children, the sensitive periods unfold very early (i.e., some prodigy children can learn the alphabet as soon as two years of age) and they overlap, which gives them the power for intellectual growth in a very short period of time. Due to this overlapping, prodigies seem to be almost always in sensitive periods (Shavinina, 2010). Because sensitive periods are present in any individual's development (typical or atypical) (Schaffer, 2004), it is unlikely that the sensitive period per se, but rather the overlapping of many sensitive periods, could represent a mechanism. This idea needs empirical proofs before one can assert the presence of this kind of mechanism.

There is some indirect evidence that sensitive periods play a role in this phenomenon. Brant et al. (2013) showed that adolescents with high IQ experience longer sensitive periods and longer influence from the environment compared to adolescents with lower IQ. The study suggests no direct causality, but leaving aside the debate over considering IQ or not as a sign of giftedness, it does lend support to the idea that different kinds of sensitive periods (longer or overlapping) are a characteristic of exceptional development.

Similarly, from a developmental perspective, Simonton (1999) presents the emergenic and epigenetic model of talent development. This model suggests that an endowed capacity has multiple components which must each be inherited for the capacity to be present (i.e., emergence), and it emerges gradually during interactions between the organism and environmental stimulation (i.e., epigenetic). From this point of view, prodigies get it all together early (Simonton, 1999, p. 443). But this early manifestation is also allowed by certain domains more than by others, namely those with fewer components needed (like music, mathematics, and chess, Simonton, 1999). As such the endowed capacity is always interacting with the environment and it does so in a multiplicative manner, so that over the course of development the child becomes able to perform in unimagined ways.

Is the prodigy phenomenon domain-general or domain-specific? There is research that argues for domain specificity, especially for cognitive profiles that differ by domain. Ruthsatz et al. (2014) showed that while average or high IQ, exceptional working memory, and very good attention to details are all needed, the scores on these cognitive underpinnings differ in domains like art, music, and math. Children with math precocity had the highest IQ, music prodigies had the highest working memory scores; counterintuitively, art prodigies have low visual spatial skills that are explained tentatively via a different type of perceptual skills in talented artists, namely a very good attentional focus on details. These results speak for the idea of specific developmental trajectories that might be important to investigate if we want to fully understand the prodigy phenomenon. In other words, exceptionally early high performance in different domains might be sustained by slightly different abilities; as a consequence, we might need to analyze more thoroughly these differences.

New research suggests a link with autistic traits but also some differences when compared with autistic children. Ruthsatz and Urbach (2012) found that child prodigies have high scores for attention to detail (even higher than the group with Asperger's syndrome) but they do not have other traits associated with autism. Prodigies also had many relatives with autism. The authors ask: What moderates the lack of autistic deficits in child prodigies? And they suggest looking for a biological modifier that acts like a moderator for autism (Ruthsatz and Urbach, 2012).

Studying prodigies is made difficult by the fact that we usually acknowledge their existence after they have proved their performance; as such, it is difficult to investigate the prerequisites that are needed for becoming a prodigy. A true developmental approach would point to the mechanisms that lead to the performance of prodigies; otherwise we cannot escape the circularity of causation. This approach is still awaited for.

Genetic Versus Environmental Explanations

High achievements, which are central elements of prodigy, have been debated for a long time through the dichotomy of innate versus environmental basis. From one side, the nurture view suggests that prodigies are the result of environmental factors and an intense deliberate practice and effort. Essentially, it is suggested that enough practice and hard work is all that is needed to reach extraordinary achievements in any domain. This view is supported mainly by studies on eminent people in science, arts, and athletics whose expertise is thought to be achieved through a supportive and encouraging environment from their parents and teachers, including a long and intensive period of training. The role of environment has also been supported in studies on adult experts in piano, violin, chess, bridge, and athletics where it was found that the levels of achievement reached in these domains correlate strongly with the amount of deliberate practice in which these individuals have engaged. The argument that prodigy is mainly a result of nurture is not very sound because it is supported mainly by findings on adult expertise. These findings show at most that environmental factors are important to become an adult expert and not necessarily to become a prodigy. Although the role of commitment and hard work is necessary, nurture explanations fail to rule out the necessity for innate talent for high achievements.

The nature view on the other side argues that the prodigy phenomenon is first and foremost based on a strong biological hereditary component. Three kinds of arguments support some kind of innateness. Firstly, some studies indicate that practice alone does not guarantee the mastery of a domain. For instance, studies on music expertise have shown that the skills for piano sight-reading are facilitated by working memory and do not improve with increasing the number of hours of practice (Meinz and Hambrick, 2010). In the case of chess players, the number of hours necessary for becoming a master are highly variable and even thousands of hours of deliberate practice do not guarantee the mastery. Secondly, there are reports of high level performance achieved by children without any deliberate practice. Reports of children that achieved high performance in reading, number, drawing and music suggest that they had strong predispositions present prior to any deliberate practice (or at least not in the same way/extent as in adults). Thirdly, there are indications from twin behavioral genetic studies of music that the *rage to master* (strong intrinsic

motivation) is highly heritable. Recent proposals suggest that even the propensity towards “deliberate practice” has a genetic basis (Winner and Drake, 2018). Hard work or deliberate practice is also required for high-achievement, but it is considered that hard work depends on two factors: an inborn ability to make progress (without which children would likely be frustrated and give up) and a strong *rage to master* (Winner and Drake, 2018). These two factors are very likely determined genetically according to Winner and Drake (2018).

While the nature-nurture debate on high achievements (as well as prodigy, giftedness, talent or expertise) is ongoing, new findings from both camps reveal that the nature-nature dichotomy does not capture the multidimensional dynamics between the factors that lead to prodigiousness. Feinstein’s (2003) influential longitudinal study looked at British children from the 1970 cohort and assessed children at 22 months, 42 months, 5 years, 10 years and 26 years. Test scores from 22 months predicted the educational qualifications at the age of 26. The most important factor that predicted the relationship between test scores and educational qualifications was the socioeconomic (SES) background of the parents (measured as the parents’ level of education). A child with poor scores in the early test would be more likely to catch up if they would be raised in a wealthy or educated family, while a child raised in a poor family would be extremely unlikely to catch up. This study shows that a supportive environment has a decisive role for children’s development, especially for children who have low test scores at younger ages. This explains why it is so hard for prodigy children to rise from poorer backgrounds. Recent studies on intelligence and giftedness offer an updated view on the genetic basis of prodigy. Epigenetic results such as those of Plomin et al. (1994) indicate there are passive, active, or reactive interactions between dispositions and environment. Moreover, the genetic influence on cognitive ability appears to involve many genes, each contributing to small effects that are additive or multiplicative (Simonton, 1999). Simply, the innately gifted individual has been lucky enough to inherit cognitively beneficial versions of many genes.

Because data from genetic studies and from investigations of environmental influences are correlational and not causal, new interesting perspectives about development of high cognitive abilities come from neurocomputational modelling, for instance the work by Thomas (2018). First, the model presented by Thomas suggests that children’s early ability is not stable across development and that the performance in early development predicts only a small variance in the performance of the adults (see also the model of Simonton, 1999). Second, the model showed that individuals who scored high in early development were more likely to fall back in population rank in case their families had lower SES. Third, to be early identified as gifted, the model required that both intrinsic neurocomputational parameters and high-quality training environment to function at optimal levels. Moreover, the giftedness development was characterized by a fast rate of acquiring knowledge. Fourth, there were asymmetries between the influences on gifted and the delayed-performance children; a poor environment was not predictive of delay, but a good environment was predictive of giftedness. Unusual trajectories were not explainable by a single cause, but by interactions between multiple factors. Emergent accounts of performance (Simonton, 1999) suggest similar things; that giftedness can be impeded by the absence of any of the multiple factors (such as not having a rich supportive environment). This translates into the view that there are many ways to fail but few ways to succeed, which also reflects the small percentage of children that reach top achievements. Overall, to become a prodigy, a child needs all the genetic factors to translate into highly functional cognitive and physical functions in a highly supportive environment.

Determining the causal mechanisms for the prodigy phenomenon is a very difficult endeavour, and neurocomputational models with support for empirical studies seem to be one of the most viable solutions for future research. As described in the previous section, cognitive and developmental approaches help towards understanding how a child becomes a prodigy.

Neuropsychological Explanations

In terms of neural mechanisms and neurocomputational properties, giftedness and prodigy performance is the result of many small advantageous aspects of neural computation, potentially across multiple systems, which contribute to the development and maintenance of cognitive and physical abilities (Thomas, 2018). There is very little empirical research on the neuroscience of prodigy. Much of what is known about the neurological foundation of prodigies comes from giftedness research. Neuroscientific findings suggest that the brains of gifted children have different functionalities than the typical developed children. For instance, it has been proposed that gifted children have relatively enhanced structural, and hence functional, neurobiology in the prefrontal cortex regions responsible for cognitive control, and working memory (Geake, 2008). Other neuroscientific findings indicate that bilaterality is an important neurobiological characteristic of how information is processed by gifted people (Singh and Boyle, 2004). It has also been proposed that giftedness is a type of neural plasticity (Kalbfleisch, 2009, p 276). Increased neural plasticity might be the neurobiological basis of the overlapping sensitive periods proposed by Shavinina (2010). The exceptional accomplishments of child prodigies have also been discussed to be due to a heightened attentional control learned in early infancy. This attentional control originates through bidirectional connections of prefrontal-parietal cortex (center of working memory) and cerebellum (center of attention). It is suggested that at the base of prodigies’ exceptional memory is the increase in the ratio of cerebellum to cerebral cortex which boosts the efficiency of information processing in the cortex (Vandervort, 2009). While all these theories might be valid, to date there is no neuroscientific empirical study made specifically on prodigy children.

Prodigy and Creativity

Are prodigy children creative? This is a particularly interesting question as it is highly disputed whether we can talk about creativity in children at all (Glăveanu, 2011). Moreover, the relationship between intelligence and creativity has not yet been elucidated. The

relationship between creativity and prodigy has been amply described in the last edition of this encyclopedia. Here we will address the question from a slightly different angle. Generally, to be considered creative one must *produce relevant and effective novel products*, which is not what prodigy children are defined by. One way to understand to what degree prodigy children are creative is by analyzing two broad categories of accomplishments: expertise and creativity. Some researchers consider that creative people are makers who have transformed an intellectual or practical domain or an artistic way of expression a field, while experts are masters who have perfected their respective trades to an extremely high level. Based on this distinction, a prodigy child shows high levels of expertise and not creativity, at least not to the extent of transforming a field or way of expression. This is not to say that prodigy does not manifest any creative potential, on the contrary. One thing that prodigy children and creative people have in common is that they produce surprise and get admiration from people and socio-cultural validation. The difference is that, while prodigy children get a unanimous and instant admiration from society, some products of creative people get a harsher scrutiny, for longer periods of time, with a strong culture-dependency (see Glăveanu, 2011). Thus, this external validation might not regard the same capacities.

Final Thoughts/Intriguing Questions on the Phenomenon of Prodigies

Should we disentangle the effects of nature from those of nurture? Or should we give up this debate, just like some researchers suggest for developmental psychology in general. This latter idea is based on all the recent research that shows that neither nature nor nurture can work in isolation. In other words, genes need an appropriate environment for optimal gene expression, while taking advantage of the environmental opportunities need some innate potential. As such, we should talk about interacting factors that are not on a continuum, but on a spiral, and which could be modeled with dynamic systems theory.

Should we necessarily link the prodigy phenomenon to creativity? No: creativity is an elusive concept itself and maybe it should remain a rare phenomenon. To put it in the words of Beck et al. (2016, p. 9): "It is clear that we do not yet have the answer to why some children solve innovation tasks and others do not. Indeed, we may now also be worried about whether they even are innovators." As such, just like the literature shows so far, we have to consider as prodigies children with early expert performance, regardless of their creative outcomes.

Should we deliberately accelerate development? Extreme supporters of environmentalism are in favor of an "absurd environmentalism" (Detterman et al., 1998), the essence being that if you put enough resources and energy into any child development, they can achieve anything. This view, highly spread in the media, can give unrealistic aspirations to parents and what their children can achieve. If the innate basis is not in place, pressures on the children towards high achievements are detrimental to their development (Abeles, 2015).

Acceleration did not provide much success so far (Blakemore and Frith, 2005), and this may be an indirect proof for some kind of innateness. Until there is enough data that acceleration works and in what conditions, one should be careful as to the demands one puts on a particular child. In other words, we should allow each child to reach his/her potential, regardless if it is a prodigy child or not.

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Psycholinguistics

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Introduction: Linguistic Creativity and Creative Language

Language is fundamentally and inherently creative because every utterance spoken and word written is unique in some manner. In other words, within the reasonable confines of a language's syntax, speakers have almost limitless options when choosing not just the words they will use in an utterance, but also the ordering of those words, the way they deliver those words (e.g., tone, volume), and other paralinguistic information associated with those words (e.g., hand gestures). Every instance of language use is thus a representation of creative expression. Because psycholinguistics is a discipline devoted to understanding how humans produce, process, and comprehend language, it is, by extension, an investigation into a creative phenomenon.

This entry will review psycholinguistic investigations into what is known as *creative language* from the perspective of cognitive linguistics. Cognitive linguists are concerned with how language, thought, and behavior are shaped by one another, such as how features beyond linguistic structure (e.g., individual cognitive differences) influence language use, or how language may help researchers better understand how humans perceive and categorize the world (e.g., through conceptual metaphor). Accordingly, many cognitive linguistic studies employ psycholinguistic methods in order to explore different questions related to language and thought. As will be seen below, these methods have been particularly favored by linguists who investigate creative language, as they are used to determine whether creative and non-creative language significantly differ in terms of human behavioral responses (e.g., reading times, eye movements, sensibility ratings).

In order to gain a better understanding into this line of research, this entry will first describe general characteristics of the field of psycholinguistics, define creative language, provide an overview as to how different types of creative language have been explored using psycholinguistic methods, and finally suggest how these explorations can be aligned with more general examinations of creativity from the perspective of psychology.

Psycholinguistics

Psycholinguistics is a marriage between psychology and linguistics devoted to investigating connections between psychological processes and language use. Researchers in psycholinguistics are therefore varied in their approaches and research interests and investigate a broad number of research questions related to language, such as processing, production, storage, impairment, acquisition, and more. Psycholinguists have developed a number of specialized experimental tasks which measure behavioral responses to linguistic stimuli, including reading times, eye movements, physical responses, electrical activity in the brain, and so on. Data in these experiments are typically (but not always) measured using extremely small units, such as the number of milliseconds it takes to press a button in response to linguistic stimuli, or the distance that a subject's eyes move while reading different words in a sentence.

One of the goals of psycholinguistic research is to develop representative models for how language is processed and stored in the brain. There have been an overwhelming number of psycholinguistic models developed over the past decades, and these models are divided into those which explain written language comprehension, spoken language comprehension, spoken production, and so on. These approaches are further segmented into models explaining the lexicons (i.e., the mental representation of words and concepts) of monolingual versus multilingual language users. Modern psycholinguistic evidence suggests that language is stored in a probabilistic network of interconnected features, including linguistic structure (e.g., pronunciation, syntax), concepts, and other linguistic information which simultaneously activate and interact with one another during language use.

Creative Language

Recognizing that language production is an inherently creative act, there is a difference between the creative process of language production and the production of language that is itself considered creative. This distinction appears small at first but is fundamental to psycholinguistic investigations of creative language taken up here. From this perspective, creative language is defined as any sort of manipulation to language that results in an interpretation that is unexpected or otherwise unique (Gerrig and Gibbs, 1988). When describing creative language, there is usually a contrast made between the surface-level meaning of an utterance, also referred to as the *literal* meaning, and the alternative, creative meaning of an utterance. Generally, the creative meaning of an utterance cannot be inferred through a semantic decomposition of the literal, surface meaning of the utterance, but instead requires some additional cognitive processing in order to decode the intended meaning. Two of the major types of creative language that have attracted a large amount of attention in this area are figurative language and humor.

Figurative Language

Figurative language is a broad category of language that includes metaphor, idiom, verbal irony, satire, and more. Of these different examples of figurative language, two have received extensive investigation using psycholinguistic methods: metaphor and verbal irony.

Metaphor. Metaphor is the most widely studied form of figurative language, and the one most closely associated with language and thought. This is primarily due to work in Conceptual Metaphor Theory. According to this theory, conceptual metaphors are said to be not just an example of linguistic creativity but are reflective of fundamental processes behind human thought. Specifically, this theory posits conceptual metaphors are representative of the system employed by the human mind to categorize and understand different entities in the world. Conceptual metaphors are usually described using an *A is B* formula, where a target entity *A* is re-categorized by placing it into a different conceptual domain *B*. This re-categorization is completed when some, but not necessarily all elements of the source domain (*B*) are transferred to the target (*A*), which provides new ways of interpreting and understanding the target entity. For instance, in the conceptual metaphor *lawyers are sharks*, abstract elements of sharks (e.g., predatory, dangerous) are mapped onto concrete understandings of lawyers, so that the basic understanding of a lawyer (i.e., a person trained in the law) is adjusted to also include new concepts related to sharks (i.e., a person trained in the law who is also ruthless and predatory). Conceptual metaphor is thus an incredibly efficient way to communicate meaning because it allows for the expression of difficult concepts in a relatively concise yet vivid manner (see Metaphors).

Verbal Irony and Sarcasm. Verbal irony (i.e., spoken irony, as opposed to situational irony) is another widely investigated form of figurative language. Theoretical definitions of verbal irony have continuously evolved since the oppositional theory of irony first defined verbal irony as an utterance which means the opposite of its literal form. For instance, if a bleary-eyed office worker arrived unenthusiastically to work on a Monday morning, she might quip “*I love Mondays.*” The oppositional account of verbal irony considers this utterance as ironic because it is clear that the speaker actually means the opposite of what she said (i.e., that she does not in fact like Mondays). However, this definition of irony is unable to account for ironic utterances that cannot be reinterpreted as the opposite of their literal meaning. For instance, a frustrated teacher exclaiming “*I love it when you’re on time*” when a student arrives late to class does not actually mean the teacher enjoys it when the student is late, but the utterance is nonetheless ironic in that situation because of the opposition between what was said, the context of the situation, and the more appropriate meaning. As such, the definition of verbal irony has been refined by scholars over the past several decades to now describe irony as an utterance that is both inappropriate yet relevant in a particular context (Attardo, 2000).

Humor

Much like figurative language, verbal humor (i.e., humor delivered through language) is a broad category and includes essentially any example of language that evokes a sense of mirth. Thus, while there are purposeful examples of verbal humor, such as canned jokes, puns, and other forms of wordplay, almost any utterance (including figurative language) can be perceived as humorous in a particular circumstance. Regardless of humorous intent on the part of the speaker, the process of humor comprehension has been typically described as the resolution of some form of incongruity among linguistic form, semantic meaning, context, and pragmatic knowledge. Resolution of this incongruity, such as recognizing the double-meaning of the word *coat* in the pun *the freezing painter hurried to put on a second coat* is where the sense of mirth and humor is said to arise.

Psycholinguistics and Creative Language

There has been a historic tendency for researchers and teachers in language and linguistics to treat figurative and humorous language as a deviation from the ostensibly normal, economical, and strictly communicative function of non-creative language (Glucksberg, 2001). Thus, it may not be surprising that some researchers interested in studying creative language were motivated to develop psycholinguistic models aiming to explain how creative language is produced and understood as an alternative process to non-

creative, (supposedly) standard language use. Accordingly, much of the early psycholinguistic research into creative language carried an assumption that creative language is somehow handled differently in the brain when compared to non-creative language (a point that has been long and sharply contested in the field but continues to persist). For both figurative language and humor, early models and experiments were designed to test predictions of the Standard Pragmatic Model.

The Standard Pragmatic Model. The Standard Pragmatic Model (SPM) represents a starting point for many theoretical descriptions for how hearers process and comprehend both humorous and figurative meaning. According to the SPM, figurative meaning is the result of a re-interpretation of a figurative utterance based on the pragmatic context within which it is stated. To understand the figurative meaning of an utterance, a hearer must first interpret the literal meaning of an utterance, reject the literal meaning based on contextual information, and then compile a new, figurative meaning, based on their understanding of the speaker's pragmatic intent and the surrounding context. Therefore, the SPM assumed that figurative meaning was dependent upon an initial literal meaning, which would suggest figurative meaning comprehension should take longer and require more cognitive effort than literal meaning comprehension, as multiple meanings must be considered.

Psycholinguistic Studies of Creative Language

Partially motivated by the predictions made by the Standard Pragmatic Model, early psycholinguistic research into figurative language comprehension was concerned with answering whether or not a hearer must first comprehend and then reject the literal meaning of a figurative utterance before arriving at the figurative meaning. The general approach of these experiments was to present research participants with linguistic stimuli that was controlled to bias either a literal or non-literal interpretation and then record differences in behavioral responses to that stimuli. For example, a researcher might show participants the phrase *He is a good soldier!* alongside information describing someone in two different ways: as a member of the military or as a hard worker. These two different descriptions would thus bias the same sentence to be read either metaphorically or non-metaphorically.

The researcher would then measure and compare behavioral responses among different participants to the same sentence in these two contexts. In general, slow behavioral responses would be taken as evidence that a participant expended more cognitive effort to decode the sentence, and therefore may be indicative of the two-stage processing predicted by the SPM if the metaphorical version took longer to read. In other words, the longer times would suggest that the participant first had to decode the literal meaning of the sentence "*He is a good soldier!*", compare that meaning to the context of the sentence (e.g., talking about the man being a hard worker), reject the literal meaning, and then search for an alternative and plausible meaning (namely, that the man is being compared to a soldier for similar qualities that are reflective of a good or hard worker, with the assumption that soldiers are generally perceived to perform difficult tasks and must therefore work hard).

Metaphor Processing. Metaphor was studied extensively by cognitive linguists using psycholinguistic methods. The consensus is that understanding metaphorical meaning requires no more cognitive effort than understanding non-metaphorical language. Specifically, research demonstrated conventional (i.e., familiar and commonly used) and novel (i.e., uniquely coined and infrequently encountered) metaphors take no longer to process and understand when compared to their literal counterparts. Additionally, metaphorical meaning is activated even when metaphors are placed in literal biasing contexts, suggesting metaphorical meaning is primary and interpreted first when hearers encounter metaphorical utterances. There is therefore strong evidence suggesting that metaphorical meaning is not processed any differently than non-metaphorical meaning, even if the meaning of a metaphor is not a function of the surface meaning of a metaphor's linguistic form.

Explanations for this effect include links to Conceptual Metaphor Theory, which suggests that metaphorical comparisons are representative of how the human mind conceptualizes the world (see above), and therefore the default state of thought may in fact be metaphorical, which would allow for effortless interpretation of figurative meaning from metaphorical utterances. At the same time, many metaphors are so entrenched in language they have been described as dead, suggesting that any literal meaning which used to exist in a particular metaphorical phrase is no longer the primary meaning.

Verbal Irony Processing. Similar to metaphor, verbal irony has also been extensively studied by cognitive linguists using psycholinguistic approaches. Unlike metaphor, the resulting models and understanding of how verbal irony is processed has been less conclusive, and debates remain regarding whether verbal irony comprehension is primarily a two-stage process, whether the figurative meaning of an ironic utterance can be directly accessed in a manner similar to metaphorical meaning, or some combination of both. Based on psycholinguistic experiments of ironic language processing, two main theoretical models have been produced: a direct access view and a salience first view. The direct access view is based on Gibbs (1986) and other studies demonstrating no significant differences in reading times for ironic utterances and their literal counterparts and that manipulations made to the context of an utterance significantly predict comprehension and reading times. Specifically, Gibbs (1986) found that as the surrounding linguistic contexts were changed to bias ironic interpretations of ironic statements, participant reading times became quicker, and they were better able to remember the ironic utterances. Gibbs (1986) argued the contextual information present in his examples allowed for the direct processing of ironic meaning, and that the probabilistic incorporation of contextual information during reading is how the meaning of any utterance, literal or figurative, is obtained. In other words, the direct access view does not assume any single utterance contains an inherent, decontextualized meaning, and that the interpretation of figurative meaning requires processes no different than the interpretation of literal meaning, rejecting the predictions of the SPM.

The assumptions put forth by the SPM were also called into question by Giora (1997), who believed the divide between literal and figurative meaning overlooked the actual linguistic mechanism responsible for differences in processing time: the role of salience. Initially proposed to explain the processing of metaphor, Giora (1997) argued the most salient meanings of a phrase or utterance are always processed first, regardless of contextual influence. This is because salient meanings are frequent, familiar, conventional, and thus represent prototypical or standardized meanings. Importantly, these features are *graded*, in that their relative strengths determine how salient a particular meaning is to a particular person. Salient meanings are stored in the mental lexicon, allowing for quicker access and retrieval when compared to novel meanings that must be computed in the moment. Salient meanings are not specific to literal or figurative language and are so strongly activated they can mitigate the effects of prior context biasing a non-salient meaning. This feature, according to Giora (1997), is what explains the results of research showing no significant differences between processing times for metaphor, because metaphorical meanings are encoded into the lexicon. However, when hearers encounter figurative language representative of a non-salient meaning, they must first interpret the literal meaning of the utterance in order to determine the figurative meaning. In this manner, Giora's Graded Salience Hypothesis (GSH) subsumes both the direct access and Standard Pragmatic Model of figurative language processing. When meanings are salient, they can be directly processed without needing to consider alternative meanings (i.e., direct access view) because they are readily available in the lexicon. When meanings are not salient, the literal meaning is first interpreted, rejected, and ultimately replaced with the intended figurative meaning, derived from contextual clues (i.e., the Standard Pragmatic Model).

Humor Processing. Compared to research into figurative language, there have been relatively fewer studies investigating humor processing using psycholinguistic methods. Similar to the figurative language studies discussed above, theoretical models of humor processing were built on assumptions that humor comprehension is the result of a two-stage process involving the resolution of an incongruity between an intended and humorous meaning of a joke. However, several more recent psycholinguistic studies suggest that humor does not always require a two-stage process of incongruity resolution. For example, one study measured participants' eye movements as they read jokes or non-humorous proverbs that were said to be either from a comedian or a politician (Mitchell et al., 2010). This study found that participants' eye movements could be predicted depending upon whether the joke was framed as coming from a comedian or a politician. Essentially, if participants were reading a text from a comedian, they spent more time reading the initial framing or setup of the joke in anticipation of the punchline, which resulted in quicker processing of jokes when compared to the proverbs. In other words, if the participants were expecting humor, they prepared themselves to process any subsequent humor and thus overcame any additional demands the resolution of the incongruity might make upon their cognitive processing of the text.

A different study compared eye movements for participants who read jokes and non-humorous texts that nonetheless required some form of reinterpretation of meaning (Ferstl et al., 2016). For example, one text requiring non-humorous revision began with a judge asking a man if he had anything else to say, prompting a mental image of a courtroom scenario. The man's reply however, which was a reminder that the judge had an extra appointment the next morning, prompts a revision of the initial meaning into a new meaning (e.g., that the man is not a defendant in a court case but rather an assistant to the judge). The results from this study reported significantly fewer re-readings of the initial framing of the text if the text was humorous versus non-humorous. Ferstl et al. (2016) interpreted these findings as evidence that when a revision (or resolution of an incongruity) results in humor, the reader recognizes the humorous reaction as a confirmation of the resolved incongruity and does not need to further consider the initial meaning. For the non-humorous texts, the meaning revision resulted in significantly more re-readings of the prior context, suggesting that a non-humorous resolution is less acceptable to participants. Although Ferstl et al. (2016) claimed these results cast doubt on the need for a two-stage resolution process during humor comprehension, their results more strongly suggest that humorous meaning assists readers when they encounter incongruity (but does not rule out the need for two-stage processing).

Direct Connections to Creativity. Despite studying a creative product, many language researchers do not make connections between creative language and the larger construct of creativity as a cognitive individual difference. And the converse is equally as true; many studies of creative ability and creative potential neglect the role of creative language. There are exceptions to this – humor has been identified as a facilitator of creativity, and at least two studies have reported results suggesting the ability to produce higher quality metaphors is an index of creative ability (Beaty and Silvia, 2013; Silvia and Beaty, 2012). Another study examined the influence of sarcasm use (sarcasm is a common form of verbal irony which is usually negative in tone) on the ability to solve explicit tests of divergent and convergent creativity (Huang et al., 2015). In this study, Huang et al. (2015) hypothesized that both sarcasm use and creative ability relied on a similar cognitive construct (i.e., abstract thought). In their first two experiments, Huang et al. (2015) asked participants recruited from the internet to produce, comprehend, or recall past instances of sarcasm (or were assigned to a non-sarcasm control condition) before completing tasks designed to measure creative ability (i.e., the Remote Association Task and the Duncker Candle Problem). Regardless of how sarcasm was being used, exposure to sarcasm significantly boosted participants' performance on subsequent tests of creativity when compared to the control group. In Experiment 3, Huang et al. (2015) replicated the first two experiments using human subjects in a laboratory setting, which enabled them to include more complex tests of creativity (e.g., Olive in a Glass problem), and also measure participants' abstract thought using questions from a survey. Crucially, participants completed the survey questions *after* being exposed to sarcastic or non-sarcastic stimuli and *before* completing tests of creative ability. The results reported abstract thought was significantly higher for participants who produced and listened to sarcastic utterances when compared to the control conditions, and also that participants exposed to sarcasm outperformed participants in the control conditions on tests of creativity. Huang et al. (2015) took these results as evidence suggesting that sarcasm boosted abstract thought, which in turn increased creative ability.

Summary and Suggestions for Future Research

In general, the psycholinguistic research investigating creative language has proceeded by testing whether creative language requires a two-stage meaning interpretation before arriving at a figurative meaning. While some types of creative language appear to require no more processing time than non-creative language (e.g., metaphor), studies of verbal irony continue to produce evidence suggesting verbal irony takes longer to process than equivalent, non-ironic utterances, but also that other contextual features, such as familiarity or negated language, can result in verbal irony being processed just as quickly as non-irony. One commonality of this research, perhaps best highlighted in the research on humor comprehension, is that a two-stage process of creative meaning resolution is heavily dependent upon contextual features that are partially linguistic and partially external to linguistic forms. Thus, explanations for creative meaning comprehension tend to converge towards current psycholinguistic explanations for the comprehension of any utterance. It may indeed be the case that the same processes are at work when one is comprehending a creative or a non-creative utterance, and instead of a qualitative difference between two different processing models, it is instead a quantitative difference which depends upon a number of different features that continue to be highlighted by current research in the field.

There still remains a wealth of research questions that can be investigated in order to bring linguistic and psychological conceptualizations of creativity closer together. For instance, experiments investigating whether subjects with different creativity scores (e.g., divergent thinking test performance) process or produce creative language differently would be a relatively straightforward first step towards linking these two fields, as would testing whether completing creativity tasks affects subsequent performance on figurative language processing or production. At the same time, although figurative and humorous language are considered to be creative instances of language use, some examples of creative language are highly conventionalized and ubiquitous in everyday conversation, suggesting they may be more routine than creative. It would therefore be useful to conduct studies gathering layperson perceptions of creativity in creative language using constructs developed by psychology researchers (e.g., ratings of novelty and effectiveness). This research would align well with current pursuits in the field of creativity which have identified specific linguistic features predictive of creativity scores on divergent thinking tests.

As mentioned earlier, there is a fine distinction between being creative and using creative language, and future research investigating potential relations between these two notions could serve to benefit researchers in all fields studying creativity from multiple perspectives. By obtaining a better understanding of how psycholinguists have operationalized and studied creativity, researchers in psychology can gain additional perspectives and insight into creative language, which may serve to expand efforts in the field to better understand creativity as a whole.

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Regional Creativity: Asia

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A commonly held belief is that Asian cultures are less creative than the Western culture, and such a belief was explicated in a book, entitled *"Why Asians are Less Creative than Westerners"* (Ng, 2000). Another evidence comes from the Global Innovation Index (GII), released annually by the World Intellectual Property Organization (WIPO), an agency of the United Nations since 2007, ranking countries by their capacity for and success in innovation. Calculation of GII comes from a variety of factors including both subjective (such as a survey of global CEOs) and objective data derived from several sources such as a number of scientific and technical publications, international patent and other intellectual properties, Global R and D expenditure (GERD), and innovation policies. In all past 11 reports, only one Asian country, Singapore consistently made it into the top 10 most innovative countries list. The other nine were all from Western Europe and North America. Four other Asian countries and economies, Israel, Japan, South Korea, and Chinese Hong Kong, were in and out of the top 10 list, and have gradually made it into the next tier list (typically between 11 and 15) (Cornell University et al., 2018). Although creativity does not equal innovation, at least in the eyes of global businesspeople, creativity in Asia has fallen behind of creativity in the West.

Are Asians less creative than Westerners? Answers to this question are anything but simple. One crucial difficulty lies in the definition of creativity. A widely accepted definition for creativity is its dual feature, being both original and appropriateness (also called value or effectiveness; see Runco and Jaeger, 2012 for reviews and Definitions of Creativity). However, both originality and appropriateness are relative terms and rather subjective, which depends on who (the field) judges the creative products and which domain (domain) the products belong to (Kaufman and Baer, 2012). Besides domain and field (or de facto gatekeeper), the cultural context in which the person lives and the products being evaluated also play a critical role in evaluating creativity.

This subjective nature of creativity in its conception may suggest that the kind of creativity emphasized and fostered in Asian cultures may be different from the ones explored and measured in the West. It may also imply that the Asian notion of creativity has not been fully recognized by the current society; therefore, lead to perceived inferiority in creativity by the public and scholars alike. This entry primarily focuses on examining the concepts of creativity in the context of Asian cultures, from two bodies of literature, explicit theories and implicit theories of creativity, to explore how people in Asia conceptualize creativity and whether or not their conception of creativity lead to lack of recognition of Asian creativity in today's world.

Explicit Theories of Creativity

Explicit theories refer to theories explicitly proposed by psychologists and other social scientists to examine the concept of creativity. Most explicit theories of creativity come from English-speaking countries such as the United States, based on studies of people from the West. In a review to 42 explicit definitions and 120 collocations of creativity, Kampylis and Valtanen (2010) traced the origins for the word "creativity" in English and found that word first appeared in printed form less than 125 years ago. Many explicit theories of creativity have been proposed, to examine the nature of creativity, most of which are from the United States. There are a few theories derived from Asian cultures.

Through examining both Confucian and Taoist philosophical documents and research literature on contemporary Chinese views of creativity, Niu (2012) proposed that the usage of a new concept, called “contextual creativity or co-creativity” (or *creatio in situ*), as a contrast to the western conception of creativity, which is rooted in the Biblical idea of God’s creation, create from nothing (or called *creatio ex nihilo*). She further illustrated the difference between the Chinese conception and the Western conception of creativity, and concluded four unique characteristics differentiate Chinese co-creativity to the Western concept of creativity. They are: (1) although both *creatio in situ* and *creatio ex nihilo* share the same meaning for “creation of the world,” Chinese co-creativity recognizes the significant role human beings play in the creation of the world and human civilization, and emphasizes that every human being has the potential to be creative; (2) whereas the Western notion of creativity lies in the power of the creator, Chinese co-creativity attributes creative process as a result of the interaction between the creator and the environment: therefore creativity is always contextual and interactive in the Chinese context; (3) although novelty is important for the Chinese conception of creativity, appropriateness, defined as fitting to the changing context, is viewed as more important in the Chinese conception of creativity; (4) creativity is also viewed as domain specific. Again, everyone has the potential to be creative in the domain of their own choice, which can range from an everyday field such as culinary arts to more prestigious and scholarly disciplines such as literature.

Influenced by both Confucian and Buddhist beliefs, traditional Japanese notions of creativity present a slightly different approach than traditional Chinese, that is, the emphases of the importance of nature and the universe as a source for creativity. Creativity was also viewed primarily in traditional art domains in Japan, such as the green tea ceremony, dance, traditional flower arranging, and calligraphy. When engaging in these activities and ceremonies, people can achieve “pure expression” or the highest level of creativity through meditative process of repetition and perfection of technique (Nakagawa, 1991).

There are similarities between Indian and Japanese conceptions of creativity. Rooted in Hindu philosophy, especially the Samkhya school of philosophy, the Indian view of creativity stresses the process of making connections between a person and the primordial realm, or perfect knowledge through the practice of yoga and meditation, which is called the process of self-actualization, self-fulfillment, and self-realization (Raina, 2004). The Indian word for creativity is *pratibha*, or intuitive creative power, meaning a flash of light, a revelation, a supra-rational or a beyond rational appreciation, grasping truth directly, and leading to the realization of new meanings (*navonavonmesasalini pratibha*) and the creation of something that had no prior existence (*apurvastunirmanksama prajna*). The goal of engaging in the creative process is to seek joy, to reach the highest standards in every phase of life, to discover the best of oneself, or to reach extraordinary achievement in any field of human endeavor, driven solely by strong and powerful inner urges without external prodding (Misra et al., 2006).

Taken together, explicit theories from Asia provide unique perspectives on the concept of creativity that differ from what Western scholars have proposed. Having multiple philosophical roots, namely, Confucianism, Taoism, Buddhism, and Hinduism, creativity is understood in multiple perspectives. First, the creative process as a connection between the individual and universe, and everyone has the potential to be creative through discovery of one’s potential or meditation. Second, creativity is viewed as excellence and perfection and can be achieved via purposeful learning or mediation. Thirdly, creativity is viewed as contextual and domain-specific, and mostly exhibited in the art and literature domains. Lastly, there is a greater emphasis on the linkage between old and new; therefore creativity conception in Asia is more evolutionary than revolutionary.

Implicit Theories of Creativity

Implicit theories refer to studies examining underlying beliefs of ordinary people of a society regarding their everyday understanding to certain phenomena, which allow lay people’s views to be integrated into scientific discourse.

Results from the earliest studies on implicit theories of creativity (primarily using American samples) commonly link creativity to characteristics of an ideally creative person such as being intelligent, open-minded, imaginative, energetic, active, motivated, willing to take a stand, inquisitive, curious, adventurous, ambitious, confident, determined, enthusiastic, free spirited, non-conformist, individualistic, assertive, daring, artistic, having good aesthetic taste and having a sense of humor (Runco, 1984; Sternberg, 1985). An environment with choices, the acceptance of ideas, the boosting of confidence, and the stimulus of intrinsic motivation are believed to be conducive to the development of creativity.

Studies from Asian cultures (such as China, Japan, Korea, and India), have shown that although Asians perceive some core personal characteristics, such as being intelligent, imaginative, independent, open-mindedness, to be important features for creativity, they also have different emphases.

Studies using Chinese samples from Mainland China, Hong Kong, Taiwan, or Singapore, indicated that some personal characteristics, such as “having a sense of humor” and “having aesthetic taste,” are deemphasized in the Chinese conception of creativity. In contrast, other characteristics, such as being honest, responsible, self-discipline, selflessness, and making a significant contribution to society are linked to creativity (Chan and Chan, 1999; Rudowicz and Yue, 2000).

Similar to findings from Chinese societies, studies from India revealed a greater emphasis on relational, social, and interpersonal aspects rather than personal, cognitive, and utilitarian aspects of creativity among a sample of Indian college students (Panda and Yadava, 2005). Creativity in Indian culture is also viewed as domain-specific (Misra et al., 2006) and as seeking connection between inner and outer existence. Being able to re-interpret traditional ideas in the domain of music and literature, making original contributions, and being able to synthesize and integrate are perceived as chief characteristics of creativity in the domain of sciences. Overall, compared with the Western notion of creativity, the Indian conception of creativity emphasizes affective, social,

and intuitive elements, and places greater value on intuition, insight, introspection, the ability to look inwards, open mindedness, and on creating a relationship between external surroundings and internal processes (Sen and Sharma, 2011).

Studies of Korean conception of creativity also demonstrated some cultural variations. Hong and Kang (2010) studied conceptions of creativity between Korean and American secondary science teachers, and found that Korean teachers tended to consider ethics as a more important criterion for judging creativity than the US teachers. They also placed more emphasis on the importance of teaching strategies such as providing students with more thinking opportunities in class in fostering student creativity while the US teachers emphasized the importance of environmental or emotional support. Lim and Plucker (2011) also reported that although Koreans have a similar conception of creativity to Westerners, they tend to associate creativity with some negative personality traits such as deviance, suggesting that being creative may not be socially desirable in the Korean cultural context.

Direct evidence of Japanese implicit theories of creativity is sparse. In one study, Zhou et al. (2013) studied Japanese teachers' implicit theories of creativity and found that production of a large number of ideas (fluency of divergent thinking) was not viewed as important in characterizing student creativity. Instead, coming up with original ideas and refinement of the ideas were viewed as more important. There is also a greater emphasis on traditional arts in the Japanese conception of creativity (Ramos and Puccio, 2014).

Interestingly, there are a few cross-cultural studies that directly compare implicit theories of people from East and Southeast Asia and the United States. For example, Ramos and Puccio (2014) studied implicit theories of creativity between Americans and three main groups of ethnic Singaporeans (Chinese, Malays, and Indians). They asked participants to rate the importance of creativity in two types of peoples, innovators (those who break the rules and create their own rules) and adaptors (those who follow the rules), as well as their perception to creative individuals. The results showed that both Americans and Singaporeans listed thinking out of the box and being new, innovative, and unusual as being important to creativity. Creativity was also perceived to be associated to Kirton's innovative cognitive style, rather than the adaptor's cognitive style. Cultural variation existed only in the top categories, in which Americans and Malay Singaporeans tended to associate creativity with the arts or with being artistic, whereas Chinese and Indian Singaporeans tended to emphasize being new, innovative, and thinking out of the box as defining creativity. This lack of emphasis on being artistic or with having aesthetic taste in Chinese people was consistent with other studies of the Chinese conception of creativity (e.g., Rudowicz and Yue, 2000). Overall, the study concluded that although a more collectivist oriented culture, Singaporeans share similar conceptions of creativity to Americans in which seeking innovation and breakthrough are highly valued. They attributed this lack of cultural variation in people's implicit theories of creativity to Singapore's national desire for improving its citizens' creativity and to learn from the West for the continued growth of its economics.

Tang et al. (2014) did a study comparing American and Chinese students' implicit theories of creativity in computer sciences. They found that both American and Chinese samples described creativity in computer sciences as: (1) smart/effective, (2) outgoing, (3) thinking originally, and (4) unsociable. Cultural differences were exhibited in the relative importance of each of the four factors in the conception of creativity: whereas American participants rated being smart/effective and outgoing more important than their Chinese counterparts. Chinese participants rated having creative thinking as being more important in evaluating creative computer scientists than their American counterparts. Tang, Baer, and Kaufman speculated that this cultural difference could reflect a strong desire to catch-up within Chinese laypeople's view of creative thinking. No cultural differences were observed on the factor of "unsociable," which was inconsistent with findings from another study in which creativity was rated as relatively undesirable for the Chinese (Chan and Chan, 1999). They concluded that, at least in the domain of computer sciences, people from both cultures hold similar implicit theories of creativity. They believe that cultural influences on implicit theories are more complex than explicit theories have suggested.

Paletz et al. (2011) asked American, Chinese, and Japanese college students to generate words and phrases associated with creative acts and behaviors of individuals. The entire list was coded as either external (that is, needing to involve others, such as social interaction, sports, and cooperation), internal (that is, can be done individually, such as thinking and designing), neither external nor internal, or both. The results revealed that both Chinese and Japanese students showed preference for the external, whereas Americans showed a preference for the internal, a direct evidence that Asians place a greater emphasis on social aspects than their American counterparts.

Conclusions

In viewing both implicit and explicit theories of creativity in Asia, what can we conclude the defining features of creativity among Asians? And importantly, what are some differences between Asian than the Western conceptions? Here are some highlights:

Individual Versus Social

It is clear that western conception of creativity places a greater emphasis on individual characteristics of creative individuals, such as having specific personality traits and cognitive styles. Asians place a greater emphasis on social aspects of creative acts or products, such as teamwork and support from others (evidence from Korea), interaction between the creator and his or her environment (evidence from China), as well as having significant contributions to the society (evidence from China, Korea, and India). The social aspect of creativity is unique in the conceptions of most Asian countries including China, India, Japan, and South Korea. In other words, compared to the people from the West, Asians values social contribution of the creators more than individual characteristics

of the creators. This is perhaps the most salient departure between the two conceptions, and it is also consistent with the worldviews, one being individualist in nature and the other collectivist.

General Versus Contextual

Creativity was viewed as a general cognitive ability—divergent thinking—in the West and only recently has been viewed as domain-specific. On the contrary, as illustrated in this chapter, rooted in their perspectives and philosophical traditions, creativity has been continuously viewed as contextual and domain-specific in Chinese and Indian cultures. Evidence from studying people's implicit theories also supports the idea that creative artists and scientists are viewed as having different traits and styles from the Asian perspective, and should be dealt with differently.

Novelty Versus Appropriateness

Both cultures view novelty and appropriateness as defining features for creativity, but do people view them equally in judging creativity? The literature has provided an inconclusive answer to this question. Studies of explicit theories confirm a general stereotype that Westerners place more emphasis on novelty and Asians place more value on appropriateness; although appropriateness is a relative term, and people from different cultures may perceive appropriateness differently. More studies are needed to further examine cultural differences in the novelty-appropriateness dimension of creativity conception.

Revolution Versus Evolution

Whereas Westerners often view creativity as a breakthrough between new and past products (a revolution or radical change), Asians often view the importance of linkage between past and new (an evolution or an incremental change).

The Role of Intrinsic Versus Extrinsic Motivation

Western theories have emphasized the importance of intrinsic motivation to creativity. According to Amabile's (1996) componential theory, creativity is driven by intrinsic motivation; any constraints from outside such as rewards, deadlines, observation, peer critiquing, and even explicit coaching would diminish people's intrinsic motivation thus negatively influencing creativity. However, the theory has yet to be fully examined in Chinese culture, especially in its relationship with the other domain specific aspects of creativity.

Lab experiments examining motivation and creativity in the Chinese context have also shown mixed results. Generally, intrinsic motivation seems to help student creativity, although extrinsic motivation is not seen as a negative. For example, in one study, Niu and Liu (2009) found that the creativity of Chinese students increased when they were explicitly told the goal of the creativity and the means to attain creativity. Chinese participants are also more affected by special instructions that explicitly encourage them to be creative, perhaps because of the need for "permission" to be creative (Niu and Sternberg, 2003).

After examining the literature of explicit and implicit theories of creativity, one notable conclusion is that conceptions of creativity are inseparable from cultural values and cultural practice. Rooted in collectivist and interdependent-self cultural traditions, Asians tend to put collectivist interests and societal needs above their individual interests. Historically, creativity was more likely to be expressed in art and literature. These characteristics are supported by studies from both explicit and implicit theories of creativity.

There is a discrepancy between the explicit and implicit theories in terms of relative importance of novelty and appropriateness in creativity. Explicit theories suggest that because of the constant consideration of collective interests, appropriateness is weighed more and originality less in judging creativity among Asians, compared to Westerners. Evidence from implicit theories, however, do not support such a claim. One interpretation is that influenced by Western cultures; contemporary Asians adopted a more Western notion of creativity in their conception of creativity. It is important to note that most studies of implicit theories were conducted in major cities and used university student samples, where the culture is more westernized or globalized. Moreover, there is an increasing demand for creativity in scientific and technological domains in Asia, where the definition of creativity seems more universal than cultural-specific in nature. It is also an area many Asians feel they are behind the West. Nevertheless, some unique characteristics for Asian conceptions of creativity highlighted in this entry can enrich people's understanding of the nature of creativity and may provide some new perspectives to nurture individual creativity.

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Regional Creativity: Cross-cultural Differences in Creativity[☆]

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Introduction

Making cross-cultural comparisons is by no means an easy task and making cross-cultural comparisons with regard to creativity is even more challenging, given the complexity involved in this multifaceted concept. For example, the focus could be on the creative individual, the creative process, product or outcome, the environment (sometimes called “press”) in which creativity occurs (and which in its psychological sense includes other people)—or indeed any combination of these. Traditionally, Western cultures have been regarded as placing greater emphasis on an end product, whereas Eastern cultures have been seen as putting greater emphasis on the creative process (see [Lubart, 2010](#)).

Then there is a question of the *level* of creativity under consideration, for instance, whether high-level creativity is the appropriate focus of attention or whether everyday creativity merits recognition. Terminology can also be problematic. For example, in psychology, those working in different psychological traditions may use different terminology to denote the same creative phenomena (see for instance [Fryer, 1989](#)).

Furthermore, in many languages, there is more than one word to denote creativity. For example, according to Kwasniewska ([Fryer and Fryer-Bolingbroke, 2011](#)) in Polish, *twórczość* is used in an artistic context to describe the sum of one’s creative work rather than one’s potential. It is most often used to describe the fact that a person creates something. It is more important that something comes to life than the fact that this thing is unique or novel. For scientists, however, *twórczość* always needs to be both novel and valuable. *Kreatywność* is used in business contexts to describe one’s intellectual potential rather than one’s work, as a feature of character. So in Polish you would say that a person, but not a picture, is *kreatywny*. The term *kreatywny* often means that someone is innovative and produces novel ideas, although these are not necessarily valuable.

[Fryer’s 1989](#) investigation into teachers’ views on creativity also revealed significant intergroup differences in perceptions of creativity that indicated that everyone does not mean the same thing when referring to creativity and researchers need to be aware of this ([Fryer, 1989, 1996; Fryer and Collings, 1991](#)). Although it has been widely accepted that it is useful to adopt some objective criteria for defining creativity, even these pose challenges for a cross-cultural approach. For example, the four creativity criteria (novelty, transformation, condensation, and appropriateness) identified by [Jackson and Messick \(1965\)](#) have proved invaluable for creativity researchers, but these do not always translate well across cultures.

[☆] *Change History:* November 2019. Marilyn Fryer & Caroline Fryer updated the text throughout the article.

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Novelty

In the West, novelty in some form is normally regarded as a necessary condition of creativity, and it is the impact that a novel product or process has, which determines whether or not it is seen as creative. To assess whether a creative product could be regarded as novel in a global sense would require a high level of specialist knowledge. On the other hand, it can be argued that a creative product is novel for the person who made it (for example, a child doing something for the first time, with no knowledge of what has gone before). Societies also vary in terms of the amount of novelty they will tolerate. To illustrate this, [Cropley \(2004\)](#) gave the example of the sentencing of Galileo in 1633 for supporting the Copernican position that the earth orbits the sun.

According to Sharma Sen and Sharma ([Fryer and Fryer-Bolingbroke, 2011](#)), in India, among the traditional rural–semiurban population, creativity is perceived as the skill to create artifacts, which they believe need not be original every time. However, whether such artifacts can legitimately be called creative is a matter for debate and depends on who is qualified to judge. Sharma Sen and Sharma pointed out that, among the urban educated, the Western notion of creativity (implying novelty, originality) is accepted. Whether or not Western influence is desirable is open to debate—for instance, does this result in a loss of cultural diversity?

Transformation

In Western cultures, there is an assumption that a highly creative new product demonstrates a radical shift in approach. However, this may not be the case in some Eastern cultures. For instance, [Lubart \(2010\)](#) described how Li compared Chinese ink-brush painting and modern Western painting:

Chinese ink brush painting was viewed as a “vertical” domain in which some elements are essential in each work, and certain aspects can be modified ... In contrast, modern Western painting is a horizontal domain with novelty allowed, supposedly, on all aspects. Thus, novelty can occur “in all directions” in modern Western painting, but only in certain directions in Chinese ink brush paintings.

Condensation

[Jackson and Messick \(1965\)](#) described condensation as the capacity to allow continued contemplation without exhausting meanings and implications. This criterion seems more appropriate for great works of art, music, or literature, rather than, for example, an invention. Perhaps this is the most culturally transferable of Jackson and Messick’s four criteria.

Appropriateness

This concerns the extent to which a product is appropriate to its context. [Paletz and Peng \(2008\)](#) used an implicit theory approach to explore the validity of appropriateness and novelty among over 400 students from Japan, China, and the United States. To do this, they used repeated measures scenarios of cooking and textbook products. They concluded that appropriateness was more important for Americans and Japanese for evaluations of creativity and desire for products. They also concluded that while novelty was important for them all, the Chinese were more swayed than the Americans by novelty with regard to their degree of desire for the product.

The Social Context of Creativity

The fact that creativity does not exist in a vacuum, but in a social context has long been stressed both by Stein ([Fryer, 2004](#)) and [Cropley \(2004\)](#). Cropley (an Australian who spent much of his career working overseas) argued that society is ambivalent about creativity and that two opposing forces are operating: conserving forces which resist change and innovating forces that favor it. Importantly he noted that not all conservation is reactionary or undesirable and not all innovation is beneficial. Furthermore, creativity can be achieved through evolutionary as well as revolutionary change.

Evidence that societal goals and cultural values influence the focus of creative endeavor was put forward by [Razik \(1967\)](#) who argued that economic need and the political situation have tended to influence assumptions about creativity. He pointed out that in the United States even though the Progressive Education Movement, which focused attention on the creative qualities of children, was widespread as early as the 1930s, it was only after World War II in the presence of the Russian threat that creativity could not be left to the chance occurrence of the genius. He observed that, when the need for creative individuals was great, people began to entertain the possibility that perhaps anyone could be creative, and that creativity was amenable to education. [Cropley \(2004\)](#) described how in the United States, the National Defense Education Act adopted a concept of creativity which went beyond its earlier aesthetic definition, to one in which creativity was seen as a key factor in society’s prosperity and survival, thus launching the age of social creativity.

While there are some significant differences between East and West in terms of creativity and culture, the situation is really more complex than this. For example, [Kapur et al., \(1997\)](#) drew attention to the similarities between Indian and Western scientists. However, [Hussain \(2004\)](#) observed that, whereas the West relies on a scientific approach of hypothesis-building and the search for evidence, the traditional Eastern system places great emphasis on building a solid foundation and then building up basic knowledge step by step. But he maintained that the downside of this approach is an overemphasis on the foundations and rote learning—something which he suggested has robbed people of the initiative to make bold hypotheses about new situations and new problems. Another distinctive trait of Eastern culture he identified is humility in learning.

Hussain argued for the importance of understanding how people see creativity in order to help them to improve, and to do this it is important to understand the traditional basis for their creativity. He pointed out that Eastern philosophies like Buddhism and Taoism suggest that there is a need to loosen control and let the mind be free, because as soon as a person tries to create, “to do,” they start controlling. Instead of forcing it, they need to give it a chance to “come,” although he believes that this does not work for everyone.

In Confucianist-influenced societies, such as China, Taiwan, Singapore, Malaysia, and to some extent Japan, the teacher is seen as the master of knowledge who must be respected, and challenging those views can be seen as inappropriate. According to Sharma [Sen and Sharma \(2004\)](#), in India, school children are expected to comply with authority and follow their teachers’ (gurus’) instructions. The unwillingness to question the authority of teachers has emerged in a number of countries, although of course this is not universal within or across cultures.

Other researchers have drawn attention to features of Asian cultures which can foster creativity, including an emphasis on collectivism which can encourage working together for incremental innovations. They also highlighted the fact that Asian cultures often encourage long-term goal setting and perseverance which would be beneficial to creativity.

Hussain highlighted the incredible creativity and inventiveness of Chinese society as well as the outstanding works of great thinkers like Confucius. But despite all these achievements, he suggested that there have been no similar breakthroughs in the last 1000 years. He ascribed this change to a lengthy period of feudalism and the rigid and deeply entrenched Imperial Examination System. He contrasted this with a much shorter period of feudalism in Europe followed by the Renaissance and later the Industrial Revolution. Hussain concluded that the historical conditions in the West over the past few centuries have been very favorable to creativity and inventiveness, whereas in the East the historical conditions have been less favorable. But, he argued, the Western emphasis on individual achievement over collective effort also has its disadvantages: although it can spur people on to greater accomplishments, it results in self-centered individualism which indirectly affects creativity.

One of the ways researchers have tried to make sense of all the contrasting features of different cultures is by adopting categories such as those featured in [Hofstede’s 1991](#) study of IBM’s international employees:

- Individualism—collectivism
- Power distance relationship
- Masculinity—femininity
- Uncertainty avoidance—uncertainty acceptance

According to [Lubart \(2010\)](#), in studies of national inventiveness and innovation, it appears that societies which feature individualism, low power distance, and low levels of uncertainty avoidance are more likely to be inventive and innovative. However, countries with high levels of individualism may struggle with idea implementation, as this stage often requires a team effort.

Obviously the detailed picture is more complex, and individual cultures cannot be classed as simply as Hofstede’s criteria might suggest. Within every culture, there will be pockets of creativity as well as sections of society who resist creativity. For example, citing Lau, Hui & Ng, [Lubart \(2010\)](#) explained that Chinese culture is complex and cannot be reduced to being simply “collectivist.” Indeed [Raina \(2004\)](#) pointed out that: “creative thought in the Oriental traditions cannot be treated as a single, undifferentiated entity”. And he articulated what many literature reviews strongly suggest, that theories of creativity derive from cultures’ creation myths. The word derive seems important here since (if he is interpreted correctly) he was referring to the religious basis of creativity in each culture, whether Indian, Greek, or Judaic, for example. Hussain also emphasized how Islam laid the cultural and scientific foundations of the modern world.

In addition, Raina criticized the “narrow ethnocentric” boundaries of most creativity research and argued instead for a “garland making perspective on creativity and cultural diversity”—one which allows a diversity of approaches to flourish and which recognizes the complexity involved:

Be like a garland maker, O king: not like a charcoal burner.

Mahabharata XII. 72 20 in [Raina, 2004](#), p. 27

As Raina explained, this famous metaphorical statement contrasts the creation of a garland of many flowers and colors against a charcoal burner burning all kinds of diverse wood into homogeneous dead matter. Given the increasing ease with which information and ideas can be shared globally, it seems relevant to ask to what extent East/West comparisons will be useful in the future? Hopefully the world is not moving toward a state of “homogeneous dead matter.”

Reviewing Cross-cultural Research Literature

When undertaking cross-cultural research, the many variables discussed above clearly need to be taken into account, but even more care needs to be taken when *reviewing* cross-cultural research—ensuring that one compares like with like or that any differences are made clear. Another key consideration concerns clarity around *the criteria employed by reviewers* for the inclusion of studies in the review. Such clarity is evident in a highly comprehensive review of East/West cultural differences in creativity and innovation by [Xie and Piak \(2018\)](#) in which they decided to include both studies of “creativity” which they see as idea generation and “innovation” which they see as including “creativity (i.e., generating ideas) ... as part of the innovation process.” Not everyone would define

“creativity” so narrowly nor would they necessarily define “innovation” in this way but importantly they have made their criteria clear as well as providing information on how these and other terms have been defined in the research reports they review. Their review clearly illustrates the complexity involved in such a task. That they identified gaps in research which could usefully be addressed in the future is an added bonus.

Prior to this, [Simonton and Ting \(2010\)](#) published a useful review of research into creativity in Eastern and Western civilizations in which historiometrics had been employed as the methodology. They too make clear the complexity involved in such comparative research while drawing attention to the unique potential of this methodology. Clearly any historical cross-cultural review of creative achievement needs to take account of the extent to which different sectors of the population had the freedom or opportunity to express their creativity. In the United Kingdom, for instance, historically women faced restrictions on what they could do (and such restrictions still apply in a number of countries today) which has meant that they tend to be underrepresented in historical accounts of creative achievement. This is yet another issue of which cross-cultural researchers need to be mindful.

Creativity Researchers' Views About Their Own Countries

[Paletz and Peng \(2008\)](#) reached an important conclusion, which is to understand that:

"Implicit theories of creativity may go beyond stereotypes about East-West differences ... the nature of creativity is multifaceted: if we view it through the eyes of people across the world, we can better understand which aspects are universal and which are culture specific." (p. 299)

The views expressed below are the considered opinions of eminent creativity researchers selected for their knowledge of the creativity field in their own countries. They were asked:

- What factors do you think especially support creativity in your country today?
- What factors do you think inhibit it?
- Is there anything else you would like to say about creativity in your country?

Australia—Michelle Evans

Australia is a creative nation. Our innovative spirit can be traced back well before the colonial invasion in 1788 by the British. The place-based Indigenous knowledges connected to all corners of the breadth of Australia are embodied in creativity and cultural practices of Australian Indigenous people. These Indigenous knowledges are derived from mutual relationships with the land, seasons, flora, and fauna. Indigenous cultural and creative expressions through dance, song, music, language, and visual artistry continue to be practised in various parts of Australia. From traditional cultural expressions to contemporary artistic forms, Australian creatives draw upon the unique nature of our island home.

Indigenous innovations like the boomerang, that served as an excellent tool for many uses for thousands of years, was the inspiration of the famous patent registered by Ngarrindjeri creator David Unaipon. His ideas about perpetual motion led him to register 10 patents including the modern mechanical sheep shears. These ideas have been instrumental, including drawings designing a helicopter on the principles of the boomerang, which we now know served as the base idea leading to the design of modern-day drones. Many Indigenous Australian creatives are using drone technology today—such as the cultural entrepreneurial company, Indigital, who survey the country from the air, creating 4d maps. These maps are layered with content from traditional elders for instance, in order to create rich visual and textual environments in augmented reality.

Creativity is embraced across sectors: from education to health, from the arts to business, we can see how critical the pivotal role of creativity is in the rising knowledge economy. In the knowledge economies, where ideas and creativity represent the primary materials of the system, high levels of education are the building blocks for expertise and specialization. Australia ranks in the top 10 of tertiary educated populations in the world as well as in the top 10 for global patent filings. This traditional measure of demonstrated creativity (patents) indicates that Australia clearly supports innovation and creativity. Structural inequality inhibits access for individuals and groups to creative education, funding opportunities, and expression opportunities, as well as the opportunity to learn critical and creative thinking.

China—Hongyi Sun

Chinese people used to be very creative in the ancient days with the four great inventions, i.e., gun powder, the compass, paper, and printing. However, in the past hundred years, there have been very few original inventions from China. This echoes the famous Needham Question. Experts believe that culture is one of the critical influencing factors on creativity. Chinese cultures used to be very tolerant with many different schools of thought (without Buddhism then), for example, in the great four invention period.

Later on, it was dominated by Confucianism for a long time. Its current culture changes in some aspects as well. How current Chinese culture influences its creativity is a timely and important topic to study.

Sun (2009) used the six dimensions of national culture by Hofstede (1991) and the two dimensions by Hall (1989) to study the impact of national culture on innovation. Findings indicated that power distance, individualism, scientific thinking, and precise thinking were positively related to the innovation capability of a nation. China is very weak in equality (large power distance), individualism, precise thinking (quite nonprecise in many aspects), and extremely weak in scientific thinking. The ranking of China in these dimensions reflects a typical Confucian Society. Due to these cultural features Chinese people, especially students, are very shy and have no confidence when dealing with new ideas. Therefore, some dimensions of Confucianism may inhibit creativity in China.

However, there are some elements in Chinese culture that may support creativity. Among others, there is a paradox with regard to intuitive thinking. People normally believe that intuitive thinking should positively support creativity. This really depends on how creativity and innovation are defined. If creativity is defined as the process of generating new ideas, intuitive thinking is really positive. However, looking at the innovation process which starts with a new idea, develops it further into a feasible product (or service) and commercializes it in the market, intuitive thinking is far from enough and in fact damages the downstream stages. Chinese people and the education system are especially weak in systematic and process-oriented thinking. Even with good ideas, the ideas will lead to nothing if this involves just playing with the ideas. Therefore, a systematic and process-oriented tool like the PIPE model (Sun, 2012) is needed in Chinese creativity education and training.

The Chinese government strongly supports creativity and innovation. All its policies aim at building an innovation-based country. Chinese companies and universities are all encouraged to move toward innovation. However, the top-down push approach may backfire on the operational level. Creativity has to be bottom-up at people's free will.

Finally, there is a very practical method in China for creativity training. Many empirical studies report the positive impact of meditation on creativity (see for instance Alexander et al., 1991; Seeman et al., 1972; Alexander and Langer, 1990). China has a long history of practising meditation by Buddhism and Taoism as well as Confucianism. Surprisingly, meditation is more popular in the West than in China now. From famous entrepreneurs to ordinary engineers of Google and Microsoft, meditation is practiced. These companies even provide meditation rooms for their employees. Chinese meditation in Buddhism Zen and Taoism Taiji meditation have been influencing China, Japan, Korea, Singapore, and Vietnam for hundreds of years. It has the potential to be developed into a modern creativity training method in China.

Germany—Luzie Semmler and Verena Pietzner

Semmler and Pietzner's study dealing with teachers' and student teachers' views on creativity revealed that German teachers and student teachers who participated in the study have a positive attitude toward creativity and realize the importance of supporting creative abilities in pupils. This is encouraging as children's creativity and creative abilities need to be supported as early as possible. Indeed, schools are important institutions in the context of supporting creativity. This attitude as well as the openness and the will to deal with creativity by themselves increased not only the respondents' creativity but also the creativity of pupils in their classes.

One important point is that within the core curriculum published by the KMK, teachers have freedom to include special activities. It is more open than in other countries, the group of subject teachers within a school have the responsibility to design a school curriculum out of the core curriculum. There, they can include topics that foster creativity, especially by choosing methods which encourage respect. Usually, teaching methods that foster creativity are widely known but more as methods to foster cooperative learning or to make teaching more open. Teachers are not generally aware that these methods also foster creativity.

Another factor involved in supporting creativity in Germany is the possibility of expressing one's own way of life and individuality. Germany's economy has grown rapidly over the past few years, and all doors are open to young adults for experimenting and realizing their ideas. Furthermore, the increasing globalization and digitization, not only in Germany, but all over the world, offer new possibilities to be creative and to exchange with others. New digital media also opens up new possibilities in school to support creativity, but the new media's potential is still not reached.

Dealing with creativity in young children is an important aspect in the development of creativity. Creativity is not a talent; it is an ability that can be learned and developed by every person. Although creativity is important in every area of life, and, thus, in every school subject, in German schools, creativity remains in artistic and musical subjects. Especially in today's digitized times, economy and industry depend more and more on innovative and creative workers, because ideas are developed and spread via the Internet at incredible speed. To stand out in international competition, the German economy and industry need innovations developed in short time intervals. Creativity, therefore, needs to be a requirement for school graduates, and it should be integrated and facilitated in every school subject. This includes stimulating divergent thinking processes, supporting self-initiated learning, and allowing pupils to make and correct mistakes. These aspects are implemented in German schools only rarely. Therefore, the current classroom situation in German schools is not intended to support creativity.

Teachers also need time to be creative. Teachers in Germany struggle with many challenging tasks including children with disabilities in regular classes or the turnover at the gymnasium (switching from 8 years to 9 years). If teachers feel more and more overloaded, they do not have the time to think about creativity and/or being creative.

India—Rehka Sharma Sen and Neerja Sharma

Creativity has been valued in its diverse dimensions since ancient times in Indian society. Presently, there is a multiplicity of implicit theories of creativity extant in Indian culture, and these reveal continuity with traditional Indian philosophical thought as well as the integration of a Western world view.

Creativity, in Indian philosophical texts, is much more than either the process of creation or the novelty of the product. It is seen as a faculty, distinct from the intellect, and is referred to as *pratibha* or intuitive creative power. The faculty of *pratibha* is what enables the creator to create and communicate one's experience, and it is this faculty which enables the aesthete to grasp, experience, and understand the meaning in the creation. Creativity, or *pratibha*, lies in the communion between the creator and the aesthete though they may be separated in space and time. Creativity originates with the bliss of the creation in the artist's mind and is completed in the aesthete's heart, which fills with the same kind of bliss on experiencing the creation (Deshpande, 1989).

In daily life, it is the *agency of the self* in the process, of creation, the involvement and investment of the self in the task being done, rather than merely bringing a product into being, that is invoked in considering the self as having been creative. Multiple conceptions of creativity exist in this self-based construal, depending upon which aspect of the self is considered salient in evaluating whether or not one has been creative. Both the "meaning context" of creativity (Stark, 1965) and the "novelty context" of creativity (Nickerson, 1999) have currency in people's thinking (Sharma Sen and Sharma, 2011).

- For some, the emotional self is of salience in order to evaluate the self as creative. These individuals experience agency and involvement when they *invest themselves emotionally* in the task. Creativity is described with reference to emotions, feelings, and the subjective state of the person when involved in a task, irrespective of ownership of the idea as one's own. Thus reproducing art is seen as a creative act when it is not simply a mechanical act of copying. "Newness of thinking" or creation of something "new," "different" or "unusual," "neat," or "attractive" is of no special significance and, when it happens, is epiphenomenal.
- For some, the cognitive self is of salience, and they describe creativity with reference to the thinking and cognitive processes that accompany the act of creation. Actions, products, and ideas that are borne out of the person's *own* thinking, which are not routine, not mechanically done out of habit, where the outcome or the solution is not predetermined or previously known to the person, are described as creative. Problem-solving is seen to be as much a creative act as creation of a novel product.
 - Some assess "novelty" and "originality" of thought in a comparative sense, with respect to others.
 - Some assess "novelty," "difference," "originality," and "uniqueness" of thought with respect to one's own self.
 - Some do not stress comparison in any sense and focus on self-expression rather than being unconventional or new. "Unique" is used to describe creativity not in the comparative or quantitative sense of "rarity"; but as "uniqueness" of one's style, one's individuality as one expresses oneself through the creation.
 - Many describe creativity as the act of learning, especially in the context of education. The connotation of "newness" here is "learning new things or skills" or "what one did not know before" which is different from the connotation of "newness" as "person's new ideas." Creativity is seen to lie in the process of appropriating knowledge through one's active agency, in reconstruction and discovery of knowledge by the doer in order to assimilate it to one's self.
- Some invoke the holistic self in defining and experiencing creativity. An action or experience is perceived as creative because of the person's total involvement in it—mental, emotional, and physical. Newness of thinking is epiphenomenal, holding no special significance. Such a view is especially relevant in understanding the creativity of artists involved in creating traditional crafts and those engaged in the traditional performing arts. The element of creativity in the work as "self-expression"/"uniqueness"/"different"/"originality" and the element of recognition of the work as "new"/"novel" are seen as two distinct aspects—the former is seen to lie in the domain of the artist and the second in the domain of the audience. As such, the artists themselves do not strive for "newness"/"novelty"—it happens. Reinterpretation of the traditional is creative because it emanates from the creator's entire being.
- For some, the physical act of creation is the defining feature of creativity—a person is seen to be creative because one is doing something or bringing something into being, into physical existence. Novelty, originality and ownership of thought or emotional involvement are irrelevant.

In terms of teachers' perception of traits which ought to be there in an "ideal child," creativity-relevant traits of the Ideal Pupil Checklist, such as "independent in thinking," "courageous in convictions," "curious," and "persistent," find a place within the top five highly valued traits, and "conformity" (which is seen as a deterrent to creativity) is among the least valued traits (Sharma Sen and Sharma, 2004). However, this positive perception of creativity-relevant traits is not reflected in actual teaching practice in schools. Students and teachers largely perceive "academics" as a domain which is fixed, theoretical, and fact-based, where things have to be understood as they are and written in examination. Academics is seen to require "intelligence" narrowly interpreted as information, memorizing, reproducing, and understanding. Children do not experience a sense of agency in the classroom, which is central to their construal of creativity. Further, school tends to foster a domain-specific view of creativity, as dominantly associated with the arts and crafts (Sharma Sen and Sharma, 2009).

In terms of familial environment for creativity, key features seem to be a strong parental motivation to nurture their child's creativity and a strong internal motivation of the child to persevere in the chosen domain. The availability of cultural capital and deliberate and sustained connection with the field and the domain, positively contribute to the emergence of creativity. A cohesive family environment, where the members share a commonality of goals and purposes and availability of structured support, seems to play a central role in the nurture of creativity and its continued development. The conscious decision of the family to allocate time,

energy, and resources for the nurturance of a child's creativity, seeing it as a priority, seems to be pivotal (Sharma Sen and Sharma, 2013).

Japan—Kenichi Yumino and Tomoki Saito

Japan, in which the rice growing culture has been prospering from ancient times, has “the concept of improvement.” This came from the fact that the harvest increases whenever a farmer deliberately cares—tending the crop with water and manure and taking care of the environment. This concept is inherited up until today and draws “innovation” into study, in industry and in the business world. This brings about a steady stream of big results. For example, 39 Japanese companies were chosen as part of the “100 Top Global Innovators 2017” by Clarivate Analytics, USA. In addition, in order to maintain rural small cities and towns in which the population of elderly people increases so rapidly, people create special products and innovative businesses to attract domestic and overseas sightseers. On the other hand, many organizations have failed to innovate because of a lack of resources, including labor, and because of slow decision-making.

In Japan, the word “creativity” is often used when referring to talent and the works of special people such as a great scientist, writer, architect, painter, or musician. The number of Japanese Nobel Prize winners who are called the greatest scientists increased rapidly in the last 20 years (18 winners). The following reasons for this can be inferred. The number of university students has increased rapidly since the 1960s. Many students studied in American universities or research institutes and discovered themes that connected to the Nobel Prize and, after trial and error, they finally completed these studies. Their dexterity and their ability to think out unusual problem-solving methods may have contributed to their success.

In the 1970s, American culture influenced fields such as fashion, design, painting, photography, and music. People were developing creative works (such as animated cartoons, comics, fashion items, and costume play clothes) based on the concept of “Kawaii: pretty, lovely, cute, little, tiny” that is peculiar to Japanese culture.

One way in which creativity education is carried out is in super science high schools and elementary and junior high schools attached to colleges. Creativity education is also encouraged in high schools and in colleges with engineering sections by holding contests in programming robots and designing solar cars.

A few research projects aim to increase students' creativity through the Science-Technology-Society and Science-Technology-Engineering-Mathematics approaches, and they are obtaining good results. The authors divide “learning” into “Manabi: acquisition” and “Tsukuri: creation.” However, in ordinary schools, most lessons are Manabi and the lessons that step into the Tsukuri domain are rare. The reasons for this are:

- a) Japanese teachers and parents who do not know much about foreign advanced education think that Manabi is “all of learning” and do not demand the education that steps into the domain of creativity.
- b) Pupils learn many subjects shallowly. Therefore, they lack training in thinking deeply.
- c) On the last page of a textbook unit, problems (tasks) are always given instead of allowing students to set problems for themselves. In other words, students are trained in problem-solving but not problem setting.
- d) The utilization of the “period of integrated learning” which aims to build on each pupil's interest is insufficient.

Mexico—Lilian Dabdoub

Mexico is amidst a big transformation, and creativity is a goal of the National Education Plan (2013–18). Nonetheless, as any cultural transformation, it will take time to obtain evidence as to whether the expected changes to the educational system had an impact on children and teachers' way of thinking.

Trying to answer which are the factors that enhance or inhibit creativity in the Mexican culture is a complex task since Mexico is a mosaic built with a wide variety of cultures, socioeconomic levels, and traditions from distinct regions of a country of more than 129 million population. However, I will try to underline some aspects, which I consider, enhance creativity in the Mexican culture.

Creativity, as an original response to solve a problem, is expressed in everyday life within Mexican culture. The factors, which may enhance creativity, depend on the specific socioeconomic context. Interestingly, there is a saying *La creatividad de los mexicanos*—Mexicans are highly creative, since in general, when facing a problem and/or a situation of need, they tend to find ways of solving the need or the problem in spite of the fact that they may not have the right resources for doing so. The lack of resources ignites the spark of Mexican creativity. In the eyes of an expert, perhaps the solutions that a Mexican can implement are not the most orthodox ones, but they solve the need or the emergency.

Mexican society, in general, has shown in different tragic events, such as the earthquake in 1985 or the more recent one in 2018, their resiliency. I found that creativity and resilience relate to each other since creative skills may enhance the capacity of the individual to recover from a traumatic experience and become stronger. In addition, in such circumstances, collective creativity and solidarity are outstanding.

Recently, there have been examples of creativity in the arts, science, robotics, and cinema to mention a few arenas where Mexican creativity has been widely recognized. Cultures are influenced by the stories—the narratives that are repeated and are immersed in

a way of thinking or acting. One narrative immersed in Mexican culture is that the people who have lived in this land were colonized, and, as a colonized and emergent country, there is a perception of inferiority in relation to the conquerors. Nevertheless, one characteristic that could hinder creativity, an inferiority complex explained by authors like Octavio Paz, may turn into a strength due to the willingness of the Mexican people to embrace challenges with courage, finding ways to overcome obstacles with original approaches.

Portugal—Fatima Morais

In Portugal, there is now a stronger presence of academic research about creativity and a consequent expansion of the topic e.g., in conferences, workshops, and teacher training. The need for creative problem-solving skills has become increasingly obvious, particularly in the business world. In addition, there is the development of some private associations, such as the Torrance Center, Portugal, which provide concrete tasks in order to promote creativity—mainly in educational contexts (teacher training and creativity training programs in schools).

Despite this, creativity is not sufficiently addressed and invested in the academic/higher education domain. For example, not enough attention is given to the need to create formal courses or to offer teacher training (teacher training only exists for basic and secondary schools). At university level, creativity is still often a “taboo” and not treated as a serious and scientific topic. The result is that creativity is frequently misunderstood by the general public. Indeed, there is a discrepancy between the explicit goals of creativity promotion in the formal educational system (from preschool up to and including university) and the real investment in schools and teachers. Another barrier is the existence of “classical” myths about creativity, namely the genetic influence, the association with disruptive behaviors, the confusion between creativity, talents and giftedness, and, mainly, its primary association with the arts.

However, globally the changes are positive. There are now more scientific national and international publications about Portuguese research. Recent research has included a production/adaptation of measurement instruments, systematic control in the evaluation of training programs, the relationships with psychological variables (for example, motivation, intelligence), and the creativity of famous women. There are more schools intentionally taking action with regards to pupils’ creativity, and there is a slight increase in reinforcement through private grants and creativity development programs or methodologies in the school context. However, the business and artistic contexts are more explicitly associated with creativity; in the first case (enterprises), a growth of investment in creativity is clearly evident over the last 7 to 10 years.

Romania—Daniela Zaharia

In Romania, creativity is considered to be both an individual characteristic and a social phenomenon. Both these conceptualizations have captured the attention of researchers but mostly of practitioners. Specialists in various fields have developed programs aiming at developing the creative potential of both children and adults.

For example, one of the aims of the national educational system is to develop children’s and young adults’ creativity. Various extracurricular activities are designed for that purpose by educators from both public and private schools. The advantage of private schools (from this point of view) is that classes are composed of fewer children (15–20) as compared with public schools (25–35 children in a class). Consequently, educators have more time to interact with each child and adopt strategies that are aligned with his/her individual characteristics. During the last 10 years, a lot of private organizations have proposed educational activities aimed at developing children’s creativity and their approach was and still is successful, because many parents are interested in such proposals.

While discussing adults’ professional activities, the interest in the employees’ creative potential is high only in some domains (e.g., research and development in IT, marketing, and advertising). In the last 10 years, the phenomenon of outsourcing brought into Romania a lot of companies that provide such services (especially in human resources or client support and service areas of expertise). These companies come with very specific procedures that need to be applied thoroughly and do not encourage creativity.

In the art domain, Romania won important prizes within very prestigious film festivals (Cannes, Berlin) in the past 10 years. This international attention helped these Romanian movies gain prestige and greater interest in the film industry at home.

Creativity is also valued in higher education. Creativity courses are provided in at least four universities. Moreover, there are some empirical studies conducted in this area. For example, there is an international peer-reviewed academic journal entitled *Romanian Journal of Artistic Creativity*. Moreover, a set of scientific papers written by Romanian researchers was published in the *Creativity & Human Development* journal in 2016 on themes such as the relationship between creativity and conflict, creativity and unconscious thought, the impact of music on creativity, and talent promotion in Romania.

One interesting thing about Romanian creativity is how it reveals itself in the way Romanians protest against their political leaders. This specificity was obvious during the communist regime, when most people used to tell “undercover” jokes about Ceausescu and his wife (in those times, such jokes used to lead to very serious consequences if they were reported to the Department of State Security). Since 2017, Romanians have been using wit and humor again in their anticorruption protests.

Spain—Manuela Romo

Creation in Literature and Fine Arts is still very abundant as it has been throughout history. Also the film industry embraces a lot of creativity with filmmakers who are highly recognized and have received awards throughout the world. The same goes for fashion.

In the business world, creativity in Spain is mainly associated with advertising and marketing as well as entrepreneurship which began to be very important as a result of the economic crisis that began in 2008. This caused a lot of unemployment and demanded the development of the creative and innovative skills of individuals or small groups so that they could create new businesses. In startups, it is understood that innovation is the best tool to make a business competitive.

Unfortunately, creativity in the educational field does not receive the consideration it deserves in the training of teachers. In the university sector, topics on creativity are scarce and virtually limited to Advertising and Communication degrees. Some exceptions in other areas, such as Psychology, are due to a particular commitment to incorporate studies about creativity in universities. In general, talent continues to be associated almost exclusively with intelligence.

The truth is that neither schools nor higher education promotes creativity so that the stimulus to creativity in training occurs in isolated cases where isolated teachers use creativity as an educational tool and as a goal of individual development but without it explicitly appearing in the school curriculum. Nor has there been much consideration of innovation in the field of organizations. The public authorities have not devoted large investments to the development of R & D although the situation is beginning to change due the demands of the information society and the globalized world where the generation of new information requires creative thinking. One hopeful sign is the creation of new businesses by young people who apply innovation to their products and services often intuitively, although business schools also incorporate training in innovation and creativity techniques in their programs.

United Kingdom—Marilyn and Caroline Fryer

In many British people's minds, creativity is still primarily associated with the arts and the "creative industries" which are quite narrowly defined. However, in higher education, a significant number of academics across the board take creativity development seriously and ensure that it is included in their courses, research, and other activities. Similarly, it is addressed in staff development in UK organizations, though not always as widely as it could be.

However, government interest in creativity development in school education tends to swing back and forth on a regular pendulum, and this swing appears to coincide with changes of government, with the socialist governments being more in favor of creativity education than the conservative ones. For example, today in England, creativity education no longer has the prominent place it held at the beginning of this millennium when we were working with the then Qualifications & Curriculum Authority to ensure that creativity development was explicitly included in the National Curriculum for England. But there is a little evidence that it may soon be on the agenda again. Despite these pendulum swings, there will always be teachers who recognize the importance of developing creativity and who work hard to do so, regardless of government policy.

The main current problem for schools in the United Kingdom, stemming from a general government austerity policy, is lack of funding which means that essential services have been cut, and this particularly affects provision for children with special needs and the range of subjects offered to pupils—the arts in particular have been badly hit. There are significant teaching and support staff shortages as well as a lack of resources. This lack of investment coupled with the neglect of creativity education in schools would seem short-sighted in view of the significant problems we face locally, nationally, and globally—problems which require creative solutions. The United Kingdom is very much a nation of immigrants which can continue to benefit from cultural diversity (Fryer & Fryer, 2005; Bolingbroke & Fryer, 2009). In 2002, our charity, the Creativity Centre Educational Trust (CCET) ran the country's first *Creativity and Cultural Diversity* international conference to highlight this (Fryer, 2004). Since then CCET has launched an international e-journal, *Creativity & Human Development* (www.creativityjournal.net/) and worked on bringing the research fields of creativity and human development closer together.

Concluding Comment

Many years ago, Torrance (1962) observed that what society values will be championed there. While it is clear from the researchers' accounts above that there is evidence of the championing of creativity, the picture is patchy—not all policy-makers and gate keepers understand the relevance of creativity in human development and behavior and the need for high-quality creativity education and training. Given the complex and challenging problems facing all levels of society, a genuine commitment to expanding understanding of creativity has never been more needed.

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Regional Creativity: Cultural Expressions in South America

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Historical Context

The interactions between many cultures throughout the history of South American countries can help understand the ways creativity is expressed in these nations. The impact of the Incas, who settled in the Andes Mountains of Peru around 1200, was exemplified in their construction of Machu Picchu. This outstanding mountaintop community demonstrated their creative ways of handling architecture, astronomy, agriculture, and ceramic artwork. In Brazil and Paraguay the Tupi-Guarani Indians influenced the dialects and expressions used in these countries today.

The European conquerors were led by Christopher Columbus, who arrived in 1492, and Pedro Alvares Cabral, who arrived in 1500. The Spanish and Portuguese suppressed the Indians' culture through force and by converting them to Catholic religion and symbols. They killed the vast majority of natives, but some Indian Reservations still remain throughout S. America. In Brazil, there is a total of 350 tribes, totaling 0.4% of the population, primarily living in the Amazonas region ([Survival International, 2019](#)).

The interaction of Spanish and Portuguese settlers resulted in many conflicts over land. Finally, this rivalry was solved by the Treaty of Tordesillas, brokered by Pope Julio II in 1506. The division explains today's language difference where Brazil speaks Portuguese, while all the other nations speak Spanish.

Later on, other immigrant groups from Italy, Germany, Dutch, Japan, and China shaped and enriched their cultural expression of creativity. The presence of African slaves, brought by the Spanish and the Portuguese to work in the fields, influenced the ethnical as well the cultural life. Brazil received the largest population of Africans to work in northern states, at the sugar plantations, and in the southeast states to work at gold mines.

The presence, as well the suffering, of these slaves had an enormous impact on Brazil, as unfortunately it was the last country to abolish slavery in 1888. The historical cities in Minas Gerais (e.g., Ouro Preto, Mariana, Tiradentes) demonstrate the Portuguese and Africans' influence on the style of colonial houses and through the artwork presented in the churches, where gold was mixed with wood to represent the Saints and Catholic symbols. The most famous Baroque artist of the 18th century was the Brazilian *Aleijadinho*, insensitively nicknamed little cripple due to the loss of hands and feet caused by leprosy. He sculptured the 12 prophets in their actual size in soapstone, at the Sanctuary Bom Jesus do Matosinhos in Congonhas City. They are dressed in Portuguese robes but with African faces. The African influence upon Brazil is evident in the mixed integration of races. Africans did not influence visual arts, music, dance, food, and religious expression.

Creative Expression in Diverse Domains

The range of creative manifestations in South America is very rich due to the diverse cultures and races who live there. These countries were always open to immigrants.

Visual Arts

South America has produced outstanding creative persons, mostly from the Human and Arts domain. In the domain of Poetry, for instance, there are eminent persons who were known internationally, such as *Jorge Luis Borges*, from Argentina, *Pablo Neruda*, from Chile, and *Oswaldo de Andrade*, from Brazil. In the literature domain, excellence was recognized to *Mario Vargas Llosa*, from Peru,

Gabriel Garcia Marques, from Colombia, and *Jorge Amado*, from Brazil. In the Visual Arts domain also, there are a variety of exceptional painters, such as *Claudio Bravo*, from Chile, *Benito Quinquela Martin*, from Argentina, *Joaquin Torres Garcia*, from Uruguay, *Armando Reveron*, from Venezuela, and *Tarsila do Amaral* from Brazil, who represented their culture from a myriad of colorful perspectives. In February 1922, the “Week of Modern Art” was launched, which had a great impact on the Brazilian visual arts and literature, led by artists and poets (*Di Cavalcanti*, *Oswald de Andrade*, *Mario de Andrade*, *Lygia Clark*) with a movement named “Antropofagia” (anthropophagy), meaning the search for indigenous roots and the primitive spontaneity to express Brazilian creativity, free from European influences.

The economic situations faced by the majority of South American countries resulted in the preference for another type of visual expression, away from art galleries or museums, but open to public in wide spaces. Street art or “neo-graffiti” is considered the primary form of protest in these countries, since the first murals were painted by the Mexican painter Diego Rivera. Nowadays it is legalized and is the most popular means of expressing creativity in urban spaces in Chile, Brazil, Argentina, Nicaragua, Venezuela, Bolivia, Colombia, and Peru, reaching a profusion of outdoors and building facades throughout the cities. In these countries, it is possible to find many “barrios” or city quarters with an abundance of artwork. Several outstanding street artists can be named such as *Inti Castro* (Chile) and the Brazilians *Vik Muniz*, *Gustavo and Otavio Pandolfo* (*OsGemeos—The Twins*), and *Eduardo Kobra*, who painted the world’s largest street mural for the Olympic Games, displayed next to the Museum of Tomorrow in Rio de Janeiro.

Architecture and Design

Focusing on the domain of Architecture, there is the well-known Brazilian architect, *Oscar Niemeyer*, who designed the main buildings of the city of Brasilia, the capital of Brazil, such as the senators’ house, the presidential residence, the main cathedral, and the federal university. The outstanding modern style of Brasilia’s buildings was recognized as *UNESCO World Heritage*, in 1987. Another exceptional creative contribution can be accredited to *Burle Marx*, known as a Brazilian modern nature artist and public urban space designer, who had a great influence on tropic garden design and scenery in the 20th century. His old house, in Rio de Janeiro (Roberto Burle Marx farm), became a famous museum, recognized as holding the one of the best collections of living plants in the world. The *Inhotim Institute*, located in the state of Minas Gerais, is the largest outdoor art center in Latin America, blending sculptures, visual arts, and gardens, in a splendid combination.

Music and Dance

Another typical creative expression from South America is revealed through music and dance, recognized worldwide. One of the best examples of these manifestations is the carnival, considered one of the most popular creative ways of combining religion and culture through music and dance, which is present in many South American countries, but the best known one is in Rio de Janeiro. In Rio, the carnival parade is composed of huge amount of people dressed in different costumes, dancing in the streets or upon electric cars fully decorated, presenting the main themes of each *samba school*. Interested people from all socioeconomic classes engage in training to participate in the samba schools during a whole year, thus indicating this is really a cultural creative expression. Another Brazilian music expression, known internationally as the *bossa nova*, was created by *Antonio Jobim*, *Gilberto Gil*, *João Gilberto*, and *Chico Buarque*, who had some of their songs translated by *Sergio Mendes* in the United States. The influence of the African culture is alive today in other Brazilian music styles, such as *Batuque*, *Axé*, *Forró*, *Pagode*, *Maracatu*, and *Olodum*, which are celebrated all over the year in musical festivities in the northern states.

In the neighboring country, Argentina, the traditional music and dance style is the *Tango*, which originated in the 19th century when Italian immigrants were arriving. The music was combined with the drums brought by the African slaves, portraying a very sensitive and emotional style of singing and dancing. Among the famous Tango singers, the names of *Carlos Gardel* and *Astor Piazzolla* must be cited.

In Peru, creative dance, which represents courtship and love by two dancers, is represented by *La Marinera*, among other folkloric dances originated from the Andes region. In Colombia, the influence of Spanish and German immigrants combined with the Indian tribes resulted in the courtship dance *Cumbia*, which later blended with other modern styles and spread all over South America.

Gastronomy and Fashion

Other domains of creative expression have also to be mentioned. Peru, for example, is proud of its gastronomy, which is derived from the interesting combinations of food from the Andes with other nationalities who came to live there. Brazil is also proud of its gastronomy resulting from the interaction of African with Portuguese food habits, in addition to splendid juices from tropical fruits all over the year. Fashion is another area where S. American countries are exporting really well since their colored summer clothes are known and required internationally.

Finally, the areas mentioned above are just a few among a great variety of creative expressions in South American countries. These productions demonstrate that this continent has specific ways of demonstrating their creativity, as they are an integration of many races who came to these countries and gave their contribution. Despite the difficult socioeconomic conditions that some of these countries experienced, these circumstances did not suppress their creativity; on the contrary, the difficulties gave them the opportunity to search for new ways to express their cultural richness.

Creativity Research in South America

There are a sizable number of research studies related to creativity in South America. This can be verified in the open-access publications available on the Network of Scientific Publications from Latin America, Caribbean, Spain, and Portugal (REDALYC, 2019). A search for the word “creativity,” without limitations of the year and only from countries located in South America (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guiana, Paraguay, Peru, Suriname, Uruguay, and Venezuela), produced a total of 4384 articles.

Subsequently, with the aim to delimit the knowledge area, a second filter was applied to the REDALYC database, selecting three areas of knowledge, for comparison: Psychology, Education, and Organizational/Administration. In Psychology, 622 articles were found, 497 in Education, and 920 in Administration. These publications started from 1998, but important differences between the areas can be noted. In general, in all three areas, creativity only aroused researchers’ interest in the last decade.

The second analyzed criterion in the REDALYC database was the country of publication in three main areas of knowledge. The results indicated that Brazil is the country that most published on creativity areas (Psychology = 364, Education = 210, and Administration = 708), followed by Colombia (Psychology = 145; Education = 177, and Administration = 170) and Argentina (Psychology = 43, Education = 7, Administration = 9). 60% of these publications are written either in Portuguese (35%) or in Spanish (25%). Publications in the English language were primarily related to Administration more than other areas.

Another interesting analysis is to verify the main concerns presented by the authors from each area in the last two years (2018–19). In Psychology, the most frequently mentioned topics were related to personality, intelligence, thinking and cognitive styles, giftedness, character strengths, memory, analogical thinking, attention, intentionality, and well-being. There were also a number of articles related to social issues and their impact on creativity including obstacles to creativity, parental relationships, psychosocial factors, gender, social mobility, social politics, and cultural factors. Only four articles involved aspects related to creativity in the visual arts field.

In educational publications, three main research issues were identified: the teaching-learning process, the teaching practice, methodology and school performance. Publications in the Administration area were mostly focused on innovation with psychological constructs, related to this subject including entrepreneurship, leadership, engagement, social capital, burnout, and motivational profile.

Other aspects related to the organizational context encompassed organizational performance, sustainability, patents, customer participation, factors of organizational success, knowledge, and management. The most current issues were related to technology such as digital technology and social network.

Trends

The trends observed in South America indicated that creativity is understood in a multidimensional aspect, involving the person, the process, and the environment. These dimensions are in continuous interaction; the challenge is promoting a state of optimal combination to facilitate the personal and professional fulfillment of an individual. Indeed, the notion of self-actualization, quality of life, and mental health was prevalent rather than a focus on the quality of a creative product.

In Venezuela, as reported by Vivas (1999), there was a great interest on creativity around 1979, due to the influence of an important politician, Luis Alberto Machado. He created the Ministry of Intelligence which had programs to stimulate creativity in babies through guiding their mothers, and also provided creativity enrichment. Unfortunately, most of the programs to improve creative education were lost with the political change in the country around 1984, although educational efforts are still alive in some schools.

The Assessment of Creativity: The Search for Indigenous Measures

In South America there is a search for indigenous measures which represent the creative expression in each country. A number of instruments have been developed in each country; some of them were translated and adapted, whereas others were constructed specifically for each context.

In Chile there is a Cuestionario de Prácticas Pedagógicas para la Creatividad (Creativity-Fostering Instructional Practices Questionnaire) and the Test de Apropiación para la Creatividad (Appropriation for Creativity Test) (Barahona, 2004). In Argentina the Prueba de Producción de Respuestas Originales (Original Responses Production Teste) (Armesto, 2001) and the Escala de Comportamiento Creativo (Scale for the Evaluation of Creativity Behavior) (Aranguren and Irrazabal, 2012) are available. According to Aranguren and Irrazabal (2012), in Argentina the tools to evaluate creativity are scarce, and it is more common to find adaptations of international instruments.

In Brazil, there is a regulation issued by the Federal Council of Psychology, which approves for professional use of only those instruments which present validity, reliability, and norms for the country. Due to this fact, only four instruments are approved for psychologists’ use, which are the Torrance Tests for Creative Thinking, figural and verbal forms, adapted to Brazil by Wechsler (2006), and another two national tests, Styles of Thinking and Creating (Escala de Estilos de Pensar e Criar-Wechsler, 2006; Wechsler et al., 2012) and Figural Creativity test for children (Nakano et al., 2011). A considerable number of other creativity instruments were created for thesis and dissertation purposes, aimed to evaluate different aspects of creativity, such as barriers to personal

creativity, climate for creativity in the classroom, teaching practices for creativity, and climate for creativity in the work environment as reported by Alencar et al. (2010).

Systematic programs for stimulating creativity are found in programs for the gifted, which are present in Peru, Uruguay, and Brazil (Wechsler et al. (2018)). In Peru, in 1983, the Ministry of Education of Peru recognized the needs of intellectual gifted children and established programs for teacher training and psychological interventions in schools. The program created at the Pontifical Catholic University of Peru had as goal to identify gifted children living in poverty conditions in order to develop intervention programs for them. Peru was also the first Latin American country to organize a residential academy of Arts and Sciences for high achieving students coming from low socioeconomic conditions.

In Brazil, a federal law defining the need to educate gifted children has existed since 1971 requiring centers for gifted students within the 27 Brazilian states. However, there are only a few centers that are fully operating nowadays, usually located at the state capitals. Competition programs supported by the government such as the Mathematic and Literature Olympiads also offer opportunity for the gifted. There are opportunities to obtain scholarships (Scientific Initiation Scholarships) from federal grants to mentor high school or college gifted students, under the supervision of an university professor. Conferences to stimulate gifted education are offered every 2 years by the Brazilian Council for the Gifted (ConBraSD- Conselho Brasileiro para Superdotação, 2019), and there is a considerable production of books related to stimulation of creative and intellectual talent and gifted education.

Conclusions

Creativity in South America can be observed through cultural manifestations in visual arts, dance, music, architecture, urban design, gastronomy, etc. The foundation of the Brazilian Creativity and Innovation Association (CRIABRASILIS- Associação Brasileira de Criatividade e Inovação, 2019) was an important landmark to publicize the work in these areas by Brazilian professionals and scholars. Moreover, there is a systematic increase in research related to creativity, primarily in the domains of Psychology, Education, and Administration. Programs for stimulating creativity exist in different formats, within business organizations or in educational settings, such as gifted programs supported by local government. The Brazilian Association for Positive Psychology also divulges the diversity of Brazilian's creative works in different areas (ABP+; Associação Brasileira de Psicologia Positiva, 2019).

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Regional Creativity: Research Publications by Region

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Creativity Studies: Regional Contributions

In a world that has been globalized by information and communication technologies, a form of organic creativity has become an essential need for our well-being (Corazza, 2017; Corazza, 2019), and this points to the necessity for growth in the field of creativity studies, coupled to a sentiment of urgency. In this framework, it is relevant to provide an understanding of how the different areas of the world are contributing to this field. Given the distributive nature of the Information Society, it is increasingly difficult, but not impossible, to map scientific research contributions from a regional point of view. Here we attempt such an exercise, with the objective to provide quantitative information in terms of number of modern scientific contributions in the field of creativity studies, their impact and relative growth, the areas of research that appear to be more important for the present and the future, all seen through macroscopic geographic lenses. This quantitative analysis of regional contributions to creativity studies is approached by exploiting data analytics tools, applied to data extracted from the Web of Science in a period of slightly less than twenty years at the start of the third millennium, based on a search for keywords, and according to the criterion of assigning a scientific journal publication to a region on the basis of the first Author's affiliation. For this selected time period, this approach allows to extract a series of very interesting data on: number of publications per region and per year, principal keywords utilized by researchers, areas of research as classified by the Web of Science, number of citations per region, as well as a classification of top journals for creativity.

Quantification of Scientific Production in Creativity

This quantitative analysis was based on data collected on the Web of Science (WoS) for the period January 1st, 2000 to October 15th, 2018, including all the scientific publications that contain the “creativity” or “creative” term as a keyword or part of a keyword. It should be noted that WoS provides two variables for keywords: “Author Keywords”, corresponding to the keywords selected by the authors themselves, and “Keywords Plus”, a series of keywords automatically proposed by WoS based on the article. Because both categories of keywords are relevant in their own right, these two lists were merged into a single list of keywords for our search. Further filtering was based on retaining only the publications classified as “journal article” by WoS (removing all the books, book series, and patents), and only those for which a geographical location could be inferred. The geographical location was attributed using the country mentioned in the address of the first author. Countries were then grouped by broader geographical region, initially considering seven regions, and then reducing them to only four: Europe, North America, Asia, and the Rest of the World. The selection criteria described above were chosen as an optimal compromise between two contrasting requirements: obtaining results that are i) as exhaustive as possible; ii) as relevant as possible. The net result was a collection of 10.413 scientific articles, which were then analyzed to obtain quantitative data on the number of publications per region and per time sub-period, the principal keywords used by creativity researchers, the areas of research addressed, statistics on the number of citations, and a classification of top journals for creativity studies.

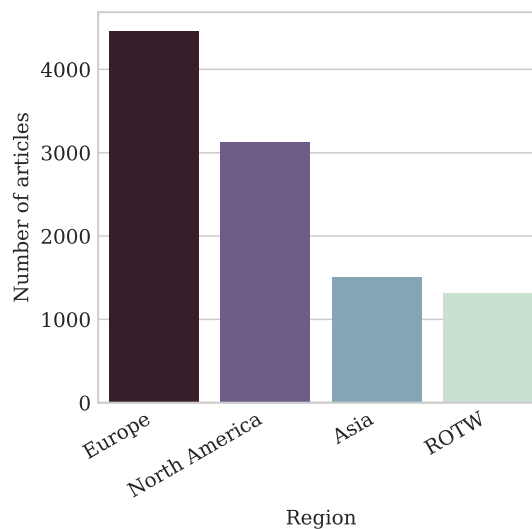
Number of Publications per Region and Time Sub-Period

In Table 1, the number of journal articles on creativity per geographical region listed in the Web of Science and published in the period January 2000–October 2018 is reported, considering the following seven regions, ranked for quantity: Europe, North America, Asia, Oceania, Middle East, Central and South America, Africa.

In order to perform more homogeneous comparisons, last four regions were grouped into a single macro region identified as Rest of the World (ROTW), and the result of this aggregation is shown in Fig. 1. It can be noted that Europe contributes for nearly 40% of the total publications on creativity in the world.

Table 1 Number of journal articles on creativity per geographical region in Web of Science published in the period January 2000–October 2018.

<i>Region</i>	<i>Number of publications</i>
Europe	4463
North America	3123
Asia	1509
Oceania	484
Middle East	436
Central and South America	299
Africa	99
Total	10,413

**Figure 1** Number of journal articles on creativity per main geographical region in Web of Science published in the period January 2000–October 2018 (ROTW: Rest of the World).

By subdividing the time period under observation into four sub-periods (2000–04, 2005–09, 2010–14, 2015–18), it is possible to appreciate the evolution in the time domain of the number of publications per period, as shown in [Fig. 2](#). As can be seen, in general there is very good growth in all regions in the world, in some cases nearly exponential.

Principal Keywords Used by Researchers

Clearly, papers on creativity can address a large variety of different issues related to this complex construct. To get a feeling of the distribution of these possible flavors, it is interesting to see which keywords are the most used in which regions, within the population of selected papers. The four regions have commonalities and differences, as reported in [Table 2](#), for the regional top 15 keywords. Not surprisingly, “creativity” is number one in all regions, while “innovation” and “performance” share second and third positions across the world, with one notable exception: in Asia, the third most used keyword is “employee creativity”, revealing a relatively important focus in Eastern countries on creativity studies for organizations and management. Also of note, and somewhat surprising, is the relatively low ranking of the “education” keyword, as well as the fact that of all the possible components of the creative thinking process, the only directly relevant keyword in this list is “divergent thinking”.

Excluding now the overwhelming presence of the “creativity” keyword, [Fig. 3](#) shows the quantitative distribution of the other 15 keywords in the European ranking through region by region histograms. Again, the most notable divergence pertains to Asian countries, where a clear emphasis on “performance”, “employee creativity”, and “work” is placed, as compared to the other regions.

Areas of Research

The Web of Science allows to extract information about the “Area of research” pertaining to a journal, through its own classification system. Only the top 15 Areas of research were kept in the analysis. It should be noted that some journals are classified in more than

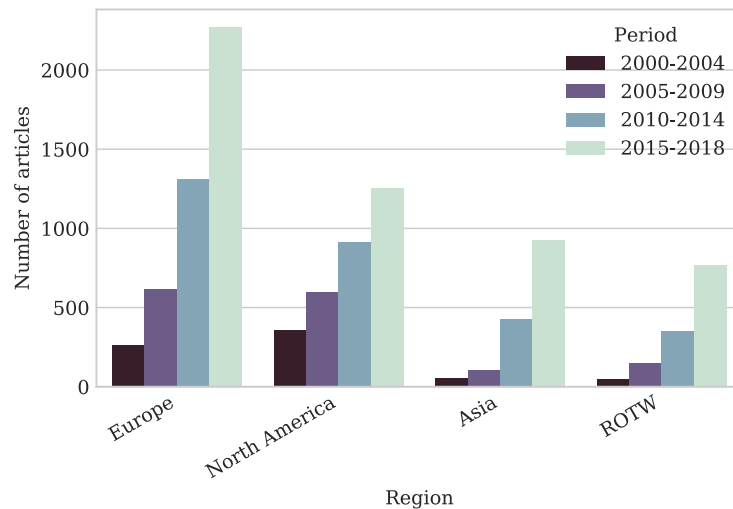


Figure 2 Number of journal articles per region per time sub-period.

Table 2 Top 15 keywords per region.

Europe	North America	Asia	ROTW
Creativity	Creativity	Creativity	Creativity
Innovation	Performance	Performance	Innovation
Performance	Innovation	Employee creativity	Performance
Model	Model	Innovation	Model
Personality	Personality	Model	Education
Divergent thinking	Work	Transformational leadership	Employee creativity
Intelligence	Divergent thinking	Work	Personality
Knowledge	Employee creativity	Behavior	Work
Work	Behavior	Organizations	Divergent thinking
Organizations	Intelligence	Personality	Perspective
Perspective	Organizations	Perspective	Transformational leadership
Education	Knowledge	Self-efficacy	Intelligence
Behavior	Perspective	Intrinsic motivation	Thinking
Management	Thinking	Divergent thinking	Knowledge
Employee creativity	Idea generation	Motivation	Design

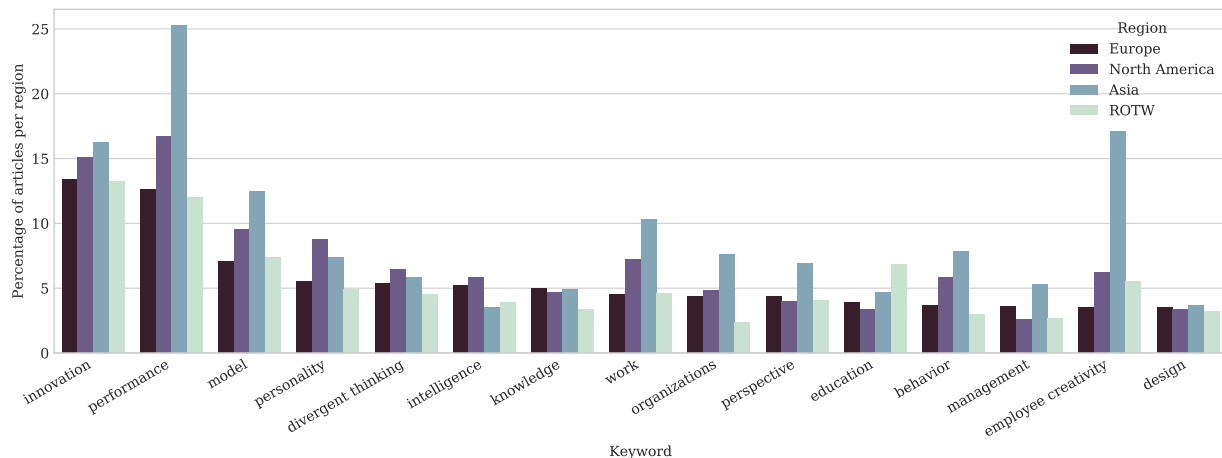


Figure 3 Percentage of articles per region mentioning each of the top 15 keywords for Europe (excluding "creativity").

one category, although 70.4% of journals are classified only in one area. Table 3 contains the percentage of papers belonging to the top 15 Areas of research in each region. Ranking is performed according to the numbers applying for Europe. It is of interest to note that “Psychology” is distinctly the number one Area of research dealing with creativity, particularly in North America, again with the exception of Asia, where “Business & Economics” is first. The latter Area of research is ranked very high also in the other regions. “Education” comes in at the third place except for ROTW, perhaps a signal of a need for training in creative thinking in vast areas of the world such as Africa, Central and South America, the Middle East, and Oceania. “Engineering” comes at the fourth place across all regions of the world. Finally, it is very important to underline that, observing this Table, it is evident that creativity is a horizontal topic that is dealt with by many disciplines. This is both a blessing and a curse, given the difficulties that researchers in creativity studies might have to face in being recognized within the boundaries of a single discipline.

Statistics for Number of Citations

Even though in terms of the number of papers Europe ranks first in the world, North America takes the lead in terms of average number of citations per paper, doubling or tripling other regions in the world, as shown in Fig. 4. This is a clear sign of the impact of creativity studies performed in North America.

Considering not only the average but a sort of discretized cumulative distribution function, Table 4 shows the number of papers per region that received a number of citations that is larger than a specified threshold. Again, North America achieves superior numbers in the entire statistics, with 13 papers at more than 500 citations (only 1 in Europe), and two papers above the astounding

Table 3 Percentage of articles per region for the top 15 areas of research.

<i>Area of research</i>	<i>Europe</i>	<i>North America</i>	<i>Asia</i>	<i>ROTW</i>
Psychology	26.80	47.01	26.84	20.41
Business & Economics	22.29	25.07	29.95	18.21
Education & Educational Research	14.99	10.34	19.75	22.23
Engineering	6.81	6.79	9.74	7.59
Computer Science	5.51	4.74	7.29	4.17
Neurosciences & Neurology	4.86	4.45	3.64	3.26
Social Sciences—Other Topics	3.67	3.36	6.49	5.84
Arts & Humanities—Other Topics	3.61	4.67	1.52	3.11
Geography	2.80	1.47	0.33	2.73
Linguistics	2.80	1.06	1.59	1.67
Environmental Sciences & Ecology	2.49	1.47	2.25	2.35
Art	2.40	0.86	0.66	2.96
Psychiatry	2.04	2.43	0.80	2.05
Science & Technology—Other Topics	1.75	1.25	4.24	2.96
Information Science & Library Science	1.64	1.73	1.92	2.05

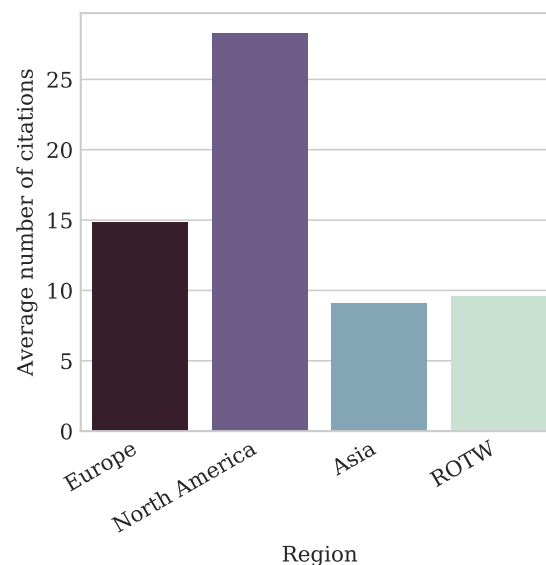


Figure 4 Average number of citations per article per region (papers in English only).

Table 4 Number of papers cited above a specified threshold per region.

<i>Threshold</i>	<i>Europe</i>	<i>North America</i>	<i>Asia</i>	<i>ROTW</i>
10	1164	1340	331	269
20	703	867	169	141
30	462	667	97	88
40	323	518	68	62
50	255	407	50	47
100	101	195	18	12
200	29	78	4	5
500	1	13	0	0
1000	0	2	0	0

number of 1000 citations. Given the different growth rate in Europe with respect to North America, these statistics should be reconsidered in 5–10 years, to verify whether any change occurred.

Further, **Table 5** considers only papers which received more than 50 citations, and maps their number over regions of the world and over scientific journals, considering the ranking that holds in Europe. 24 North America papers are present in the Creativity Research Journal, while 10 European papers are present in these statistics in the Journal of Personality and Social Psychology.

Table 5 Top journals per region for the papers cited more than 50 times.

<i>Journal</i>	<i>Europe</i>	<i>North America</i>	<i>Asia</i>	<i>ROTW</i>
Journal of Personality and Social Psychology	10	8	1	0
Personality and Individual Differences	7	6	0	0
Academy of Management Journal	6	18	6	0
Creativity Research Journal	6	34	1	1
Journal of Applied Psychology	4	17	4	1
Journal of Management	4	7	1	2
Journal of Organizational Behavior	4	5	2	3
Leadership Quarterly	4	25	2	1
Organization Science	3	9	1	1
Journal of Creative Behavior	0	10	1	0

Table 6 Fractional number of articles in the top 20 journals per 1000 publications.

<i>Journal</i>	<i>Fraction of papers per 1000</i>
Creativity Research Journal	25.8
Thinking Skills and Creativity	25.5
Journal of Creative Behavior	22.9
Psychology of Aesthetics Creativity and the Arts	16.3
Frontiers in Psychology	12.8
Journal of Creativity in Mental Health	12.0
Personality and Individual Differences	10.0
Design Studies	6.6
Leadership Quarterly	6.3
Journal of Organizational Behavior	6.2
International Journal of Engineering Education	6.2
International Journal of Technology and Design	5.7
Computers in Human Behavior	5.6
Journal of Business Research	5.5
Journal of Product Innovation Management	5.1
Journal of Applied Psychology	5.1
Creativity and Innovation Management	4.9
Social Behavior and Personality	4.6
Psikhologicheskii Zhurnal	4.5
Learning and Individual Differences	4.3

Table 7 Fractional number of articles per region in the top 7 journals per 1000 publications.

<i>Journal</i>	<i>Europe</i>	<i>North America</i>	<i>Asia</i>	<i>ROTW</i>
Thinking Skills and Creativity	11.6	4.2	7.6	2.1
Frontiers in Psychology	6.6	2.6	2.6	1.0
Creativity Research Journal	5.9	14.7	3.5	1.8
Personality and Individual Differences	5.2	2.5	1.4	0.9
Journal of Creative Behavior	4.4	12.7	3.8	1.9
Psychology of Aesthetics Creativity and the Arts	3.1	11.0	1.3	0.9
Journal of Creativity in Mental Health	0.0	11.6	0.1	0.3

Top Journals in the Field of Creativity

The previous result from **Table 5** starts to point to the final dimension we considered in this quantitative analysis, which pertains to the performance of specific scientific journals in the field of creativity. **Table 6** reports a ranking of the top 20 journals based on the fractional number of articles for every 1000 publications in the field of creativity. It is not surprising but still significant to find that the first four positions are taken by specialized journals, such as the Creativity Research Journal, Thinking Skills and Creativity, the Journal of Creative Behavior, and Psychology of Aesthetics, Creativity and the Arts. Also notable is the fact that these top 20 journals only cover about 20% of the overall publications found in the Web of Science in the reference period: one more signal of the fact that this scientific domain is horizontal to many disciplines, and that creativity is dealt with by many scientific communities.

Finally, it should be noted that the relative ranking of the journals is quite heavily dependent on the region, as reported in **Table 7**. In Europe, the top journal in terms of published contributions on creativity in the selected period is Thinking Skills and Creativity, while the Creativity Research Journal is the highest for North America. Note also that in North America a very high number of contributions appears in the Journal of Creativity in Mental Health.

Conclusions

In conclusion, it can be stated that the field of creativity studies in the period 2000–2018 has grown considerably in all regions of the world. North America has led this effort in terms of impact measured in number of citations, while Europe produced the highest number of contributions. It is important to note that the field of creativity studies appears to be horizontal to many different disciplines; most contributions come from the fields of psychology, economics, education, and engineering.

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Relevant Website

<https://clarivate.com/products/web-of-science>.

Remote Associates

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Remote Associations and Creativity

Mednick (1962) argued that a person’s level of creativity is directly related to their associative hierarchy or associative gradient. That is, creative people have flatter association hierarchies where many associations between concepts are of relatively equal strength, whereas non-creative people have steep association hierarchies where a single association is much stronger than other possible associations (see Fig. 1). According to this theory, high-creative people should produce more, and more varied, associations to a stimulus word than low-creative people. This also suggests that high-creative people produce these associations mostly automatically.

However, simply producing a greater number of remote associations will not always give rise to more creative solutions, and extremely remote associations are unlikely to be relevant to the solution to a problem. In fact, studies indicated that the use of moderately remote associations related to creative achievement. Therefore, Mednick defined the creative thinking process as “... the forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution.” (Mednick, 1962, p. 221). In this definition, simply producing more, and more varied, associations to a stimulus does not mean that a person will produce a more creative solution to a problem. The solution must also be useful for it to be considered a creative solution. While remote associations alone may be insufficient for creative solutions, the production of remote associations is an important and necessary component of creative problem solving.

Mednick (1962) developed the Remote Associates Test (RAT) to measure individual differences in the ability to make remote associations and engage in creative problem solving without requiring the person to have special knowledge specific to any field. To this end, Mednick and his colleagues constructed two college-level versions (Forms I and II) (Mednick, 1962; Mednick and Mednick, 1967) and one high school level version of the RAT (Mednick and Mednick, 1971).

The design of the RAT was based on Mednick’s definition of the creative process in terms of activation of less probable (more remote or distant) associations. Of course, the mutual remoteness of the elements can be taken too far so that some associations are so remote as to be essentially unassociated. Thus, a creative solution must both have a low probability of being produced and be

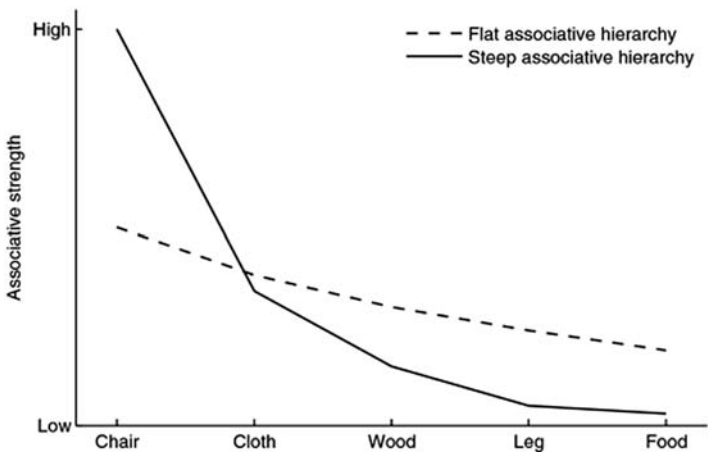


Figure 1 Association hierarchies for the concept “table”. Taken from Benedek, Neubauer, 2013. Revisiting Mednick’s model on creativity-related differences in associative hierarchies. Evidence for a common path to uncommon thought. *J. Creative Behav.* 47 (4), 273–289.

useful. These requirements are necessary to distinguish between "... original ideas expressed in institutions for the mentally ill ..." (Mednick, 1962, p. 221) and truly creative ideas. Mednick and Mednick (1967, p. 1) stated that, "... the Remote Associates Test is an operational statement of this definition."

Description of the RAT

Mednick argued that the RAT is a measure of creative thought because finding a solution requires the solver to search beyond obvious, strong associations to each word in a RAT item and consider weaker, more remote associations to the words. The first association a person is likely to retrieve for each word in an item usually will not lead to the solution. Thus, RAT items require most solvers to think of more distantly-related associations to discover an association that connects all three words.

The RAT requires making remote associations, but the associations are constrained by the set of words that constitute the item. Mednick (1962) argued that, in terms of associative theory, there are three ways of attaining creative solutions: (1) serendipity, where the various elements of the solution are elicited simultaneously or contiguously by an accidental occurrence of stimuli elements; (2) similarity, where the various elements are evoked as a result of similarity of the elements themselves or of stimuli evoking them; and (3) mediation, where the elements are evoked by mediation of common elements. Thus, the creative person must use both divergent thinking to produce uncommon associations and convergent thinking to select an association that is judged to be the solution to the problem. Although the RAT is often discussed as a test of convergent thinking, in reality it is a rare test of combined divergent and convergent thinking.

Typically, measurements of creativity have been done utilizing either open tests of divergent thinking, such as the Torrance Test of Creative Thinking, or closed tests such as Matchstick Algebra puzzles. In open tests, the examinee is encouraged to produce many possible responses scored on criteria such as originality and number of unique responses (fluency). Thus, scoring can be somewhat subjective (e.g., judgments of originality), often requiring several scorers and assessments of inter-rater reliability. In contrast, closed tests contain items with a single correct response. The RAT is an instance of a closed test with a single word scored as the correct response to each test item. This makes scoring the test easy, objective, and potentially automated, but it also makes the test less sensitive to nuances in creativity.

Each of the three versions of the RAT consists of 30 items, each item being composed of three words such as COOKIES-SIXTEEN-HEART (example from Mednick and Mednick, 1967, p. 1). All three words are associated with a single solution word (in this case, SWEET). Only common English words were used to create the items because they were considered culturally universal within the United States; therefore, the items should require no special knowledge to solve. The Thorndike-Lorge Word Count was used to determine the probable familiarity of the words making up each item, and the Kent-Rosanoff Word Association Test was used to select solution words that were valid but low probability responses to all three words of an item. The 30 items included in the original RAT (College, Adult, Form I) were selected, based on an item analysis, from an initial 100-item battery given for a period of about one year to various groups of students and professionals.

The way in which the words in any test item are associated with the solution varies both within and between test items. For example, the three words in the item COOKIES-SIXTEEN-HEART are associated with the solution, SWEET, by means of semantic association (COOKIES are SWEET), by co-occurrence (part of the compound word, SWEETHEART), or as part of a phrase (SWEET SIXTEEN). Across all items in the RAT, words within any test item (e.g., SAME-STRIKE-TENNIS) can be related to the solution word (MATCH) in a variety of ways, including synonymy (SAME is synonymous with MATCH), semantic association (one can STRIKE a MATCH), and as part of a phrase (TENNIS MATCH). This unpredictability of the type of associations between the words in the item and the solution word requires the examinee to consider a quite wide range of possible solutions. Therefore, the RAT is a strong measure of flexible thinking, which is an important component of creativity. However, this inconsistency in the type of associations required to find the solution means that it is likely that the RAT is measuring multiple aspects of creativity beyond the ability to make remote associations, or variables other than creativity such as intelligence or verbal facility.

In the original versions of the RAT, examinees were given 40 minutes to complete the entire test; an individual could choose to spend mere seconds on one test item and potentially minutes on another test item. A test taker could also potentially return to unsolved items multiple times during the testing period. The score on the RAT is simply the number of items answered correctly. The RAT was designed to be administered to individuals or to groups with equal ease and, with a single solution accepted as correct for each item, the scoring of the RAT is simple and straightforward.

Mednick and Mednick (1971) presented five criteria which guided the selection of RAT items on the High School version of the RAT: (1) Each item can discriminate between examinees in each quartile of the RAT score distribution. (2) The items do not have commonly given incorrect solutions. (3) The average performance for the overall test is 50% correct. (4) Items are consistent in difficulty across samples. (5) The items are not highly correlated with measures of intelligence.

Evaluations and Psychometrics of the Remote Associates Test

Shortly after publication of the Examiners' Manual Remote Associations Test (Mednick and Mednick, 1967), several researchers explored the reliability and validity of the RAT. Since then, there has been a relative lack of research and data examining the psychometric properties of the RAT. For an instrument to provide useful measurements, it must be both reliable and valid. Reliability and

validity are crucial for the interpretability and the generalizability of the constructs being measured. Reliability is the degree to which an instrument consistently measures a construct, both across items within the instrument and across points in time. Validity is an index of whether an instrument measures the construct it purports to measure (in this case, creativity). A measure can be reliable without being valid, but it cannot be valid without being reliable.

Performance: In his original paper (Mednick, 1962) and in the initially available version of the RAT (Mednick and Mednick, 1967), Mednick reported 16.41 mean solutions from tests of 2786 University of Michigan undergraduates, 20.10 from 81 University of Michigan graduate students in Psychology, 13.14 from tests of 73 University of Maryland undergraduates, and 18.0 from test of 288 Bennington College undergraduates. Similar scores were measured in samples from the University of Alberta and the University of Nevada. Mednick reported a mean solution rate of 19.13 from tests of 370 research scientists. These data suggest that Mednick did a reasonably good job of attaining the desired average performance of close to 50% solutions (between 44% and 67%) and a good distribution of scores allowing differentiation between levels of solving ability.

Reliability: There are different ways of measuring reliability, with the consistency of results across items within a test (internal reliability) and consistency between multiple test administrations (test-retest reliability) being the most important measures for the RAT. Reliability scores above 0.70 are generally considered to be acceptable, whereas values above 0.90 are considered excellent.

Mednick (1962) presented odd-even internal reliability correlations of 0.91 and 0.92 from two separate samples of students. In a more recent study, Lee et al. (2014) reported good internal reliability for 30 RAT items (Cronbach's $\alpha = 0.82$), replicating Mednick's reports of RAT reliability.

Validity: A critical question is whether the RAT measures creativity. Mednick and Mednick (1967) presented validity data in several categories: ratings of individuals and products; other associative measures; and measures of intelligence, achievement, and personality. Unfortunately, a substantial proportion (8 out of 12) of the relevant studies cited were unpublished doctoral dissertations, senior honors projects, conference presentations, or technical reports. The four remaining studies were related to ratings of individuals and associative measures.

Ratings of individuals: Mednick found that independent assessments of creativity made by supervising professors and coworkers positively correlated with RAT scores. For example, Mednick (1963) reported a correlation of 0.55 between RAT scores and advisors' ratings of research creativity for 43 psychology graduate students. Mednick and Halpern (1962) reported a correlation of 0.70 between RAT scores and instructors' creativity ratings of 20 architecture students.

Associative measures: Houston and Mednick (1963) examined the relationship between preference for either common or remote associations and RAT performance in 30 undergraduate students. A "high creativity" group consisted of participants with high RAT scores and a "low creativity" group consisted of participants with low RAT scores. Participants performed a verbal association task in which they picked one of two words, either a noun or a non-noun, and would receive an associated word in response. When the participant picked a noun, the experimenter would always respond with a remote association (an association that rarely occurred in word association norms), whereas non-nouns were always paired with their most common associate. There was a reliable interaction between RAT performance and preference for association over time: The "high creativity" group preferred more remote associations while the "low creativity" group preferred more common associations.

Additional assessments and validity data: As mentioned above, Mednick and Mednick (1967) reported significant correlations between RAT scores and creativity ratings of architecture students, psychology graduate students, and scientists in a chemical firm. However, other researchers did not always find reliable correlations between scores on the RAT and other measures of creativity.

Shortly after publication of the Examiners' Manual Remote Associations Test (Mednick and Mednick, 1967) several reviews of the RAT were published in the Seventh Mental Measurements Yearbook. In one review, Baird (1972) criticized the RAT on three grounds: (1) There is mixed evidence regarding its validity in predicting real-life creative achievements. (2) It is poorly related to other measures of creativity or problem solving. (3) It appears to mostly capture academic or verbal intelligence. He went on to say that the RAT is not appropriate for selecting potentially creative people, but it may be more useful for investigating the creative process. In another review, Vernon (1972) praised the RAT for being based on a sounder psychological theory than most tests of creativity. He also pointed out that the authors do not make exaggerated claims for the RAT, stating only that the RAT measures the ability to notice remotely associated elements and to access their relevant to a problem, which is an ability fundamental to the creative thinking process.

Other studies did not find a relationship between workplace or real-world creativity (as rated by supervisors) and RAT performance. Some of these null correlations may be due to non-native English speakers in the samples, which suggests that the RAT is limited as a measure of creativity because it relies heavily on verbal abilities and cultural knowledge. Some studies reported weak or no correlations between RAT performance and established ratings of creativity including measures of divergent thinking (i.e., originality, fluency, flexibility, elaboration, and composite scores) on Guilford's battery, Guilford's Alternative Uses Task, or the Torrance Test of Creative Thinking. However, RAT performance was correlated with solution rates for classic insight problems and performance on the Raven's Progressive Matrices, which we would argue requires flexible thinking and the occasional insight. Additionally, researchers found correlations between the RAT and other measures of the ability to make remote associations (Mednick's theoretical rationale for creating the RAT as a test of creativity).

Hattie and Swanson (1982) evaluated the performance of 464 students (ages 14–17) on the High School version of the RAT on the five criteria presented by Mednick and Mednick (1971, p. 6). They found that (1) the mean discrimination value for all items was 28.83% and 11 of the 40 items had discrimination values less than 20%. (2) Five items had commonly given incorrect solutions, though they do not state what percentage is defined as commonly given. (3) Only nine items fell within the desired 30%–70%

solution range, 12 items were solved by less than 10% of the examinees, and only one item was solved by more than 75% of the examinees. There were also 17 items that Hattie and Swanson felt had more than one satisfactory solution in addition to the solution deemed correct by [Mednick and Mednick \(1971\)](#). (4) The results of the test appeared to be stable across samples of high school students. (5) The correlation between overall score on the RAT and two tests of intelligence were high. Thus, it appears that items in the High School version of the RAT fail to meet criteria 1, 2, 3, and 5 of the 5 criteria established by [Mednick and Mednick \(1971\)](#) for item selection.

Contrary to Mednick's claim that the RAT does not depend on intelligence (as indicated by no [or negative] correlation with GPA), studies found that performance on the RAT was positively correlated with IQ scores (including verbal intelligence, quantitative intelligence, and fluid intelligence), word fluency, performance on English (verbal) and math standardized tests, and GPA. Performance on the RAT was also positively correlated with measures of processing speed and working memory. As the above studies indicate, evidence for the validity of the RAT as a measure of individual differences in creativity has been mixed and has been repeatedly called into question.

Strengths and Weaknesses of the RAT and Variations on the RAT

Strengths: As discussed in [Bowden and Jung-Beeman \(2003\)](#), the RAT and its variations (discussed below) have several practical advantages over more typical insight problems: (1) They generally can be solved in a short time, so many problems can be attempted in a single experimental session of 1 hour or less. (2) They are simpler than traditional insight problems, allowing better control of possible confounding variables. (3) They have single-word and unambiguous solutions, allowing the collection of more precise response time data and easier scoring of responses. (4) they are physically compact, so they can be presented in a small physical space and for a short period of time. These features allow better control and measurement of timing variables (e.g., measuring the time between presentation of the problem and production of a solution, controlling timing of hint presentation or timing of solution presentation for solution judgment tasks, etc.) and display variables (e.g., position of the problem and/or solution on the display). These features also allow for the use of various paradigms (e.g., priming, solution recognition, and hemispheric differences paradigms).

Although RAT items are not as complex as traditional insight problems, evidence that RAT items are solved by insight has been presented in the form of correlations of rated insight with degree of solution priming and in correlations with performance on both classic verbal insight problems and modern insight problems (e.g., Rebus Puzzles and anagrams).

RAT items also exhibit the three properties of insight problems that distinguish insight solutions from non-insight solutions: (1) They misdirect (or fail to direct) retrieval processes. For example, in the problem PINE–CRAB–SAUCE, the word PINE might direct the initial search of memory toward items such as PINE TREE or PINE CONE, while the word CRAB might direct search toward KING CRAB or CRAB CAKES. (2) Solvers often cannot report the processing that has led them to the solution. (3) Upon solving RAT items, solvers often have the Aha! experience ([Bowden and Jung-Beeman, 2003](#)). This third property is often considered the central defining feature of insight problems (see [Bowden and Grunewald, 2018](#)).

RAT problems elicit similar rates of Aha! experiences as classic verbal and spatial insight problems and anagrams and are marked by a similar sudden increase of “feelings of warmth” during solution. Thus, solving RAT or RAT-like items appears to involve the same component processes critical for, and the same phenomenological experience of, insight solutions to more complex problems.

Weaknesses: As mentioned above, one of Mednick's goals when designing the RAT was that it would not require a person to have any special knowledge specific to any field. However, some associations do require special knowledge (if not special training), such as knowledge that the word ACE is a term used in tennis or that KING CABBAGE is a type of cabbage.

Another weakness is that some of the items from the original versions of the RAT have become outdated, such as ROOM–SATURDAY–SALTS (solution BATH). The idea of Saturday being a special bath day is antiquated. Some of the associations are not just remote but are unnecessary for the solution. For example, in the item BALD–SCREECH–EMBLEM (solution EAGLE) it seems that the association between EMBLEM and EAGLE is not necessary to produce a reasonable solution. It could be plausibly argued that other solutions are equally acceptable (e.g., TIRE because a tire could be BALD, a tire can SCREECH, and a tire could plausibly be an EMBLEM for an automotive company). In other words, EMBLEM fits with the solution EAGLE, but EMBLEM is unnecessary for one to generate the solution. Another example of an antiquated or vague association is the item WICKED–BUSTLE–SLICKER (solution CITY), as it is unclear why a city is wicked or what a wicked city is.

Other problems stem from what might be referred to as quality control issues. An item in the original RAT, PUSS–SPIT–SPOILED, seems to contain an error. The solution, SOUR, does not appear to be associated with SPIT: a person can be a SOUR PUSS and something SPOILED can be SOUR, but the association between SPIT and SOUR is unknown to the authors. It seems that the item should be PUSS–TART–SPOILED. Another quality control issue is that some words appear both in problems and as solutions. For example, the solutions to item 8 (CHEESE) and item 26 (MUSIC) are included in the three words in item 23 (BLOOD–MUSIC–CHEESE; solution BLUE). This leads to the possibility of priming from one problem to solutions of other problems.

Finally, RAT items may require something that is analogous to more than one insight. For example, with an item such as STICK–MAKER–POINT (solution MATCH), the solution creates three compound words that are members of different categories, compared with BASE–BASKET–FOOT (solution BALL) whose solution produces compound words from a single category.

Variations on the Remote Associates Test

The RAT relies heavily on verbal knowledge, which suggests that it is limited as a measure of creativity in non-native speakers of English. Indeed, performance on RAT problems can depend on the solver's familiarity with cultural idioms and the degree to which RAT solutions are culturally associated with their problem items. Thus, over the years, researchers developed several linguistically and culturally customized versions of the test. The RAT has been adapted for or translated into a number of other languages including Hebrew, Dutch, Chinese, German, Japanese, Polish, Tamil, and Jamaican-English.

The basic theory underlying the RAT has also been used to generate variations on the RAT. The Functional RAT (FRAT) was created to depend on functional, non-language relationships grounded in reality rather than language-based associations. For example, BIRD and EGG are associated not only in written and spoken language but are related in reality. Therefore, a person without exposure to language could still understand the relation between a bird and an egg. However, not all FRAT items are purely functional associations. For example, the item FRAME-PHOTO-PORTRAIT (solution PICTURE) forms the compound phrase PICTURE FRAME, and the item COMET-LIMIT-VELOCITY (solution SPEED) forms the compound phrase SPEED LIMIT. Additionally, some problems have more than one acceptable solution. For example, for the item AROMA-FUMES-GARLIC (solution SMELL), participants gave ODOR and SCENT as solutions, both of which yield similar functional relationships to the three item words and must be considered correct. This ambiguity in what is acceptable as a correct solution may be a good thing. The FRAT would be largely a closed test that allows room for subjective judgments of creativity. This would, however, require non-automated scoring and more consideration of solutions provided.

The visual RAT (VRAT; [Oltețeanu et al., 2015](#)) is in early stages of development and presently consists of 20 items, each composed of three pictures of objects and/or scenes. For example, one practice item contains pictures of a HANDLE, a GLOVE, and a PEN. The solution to this item is HAND because it is a visual associate that co-occurs with the visual entities (i.e., a HANDLE is operated by a HAND, a GLOVE is worn on a HAND, and a PEN is held in a HAND).

A modification of the Remote Associates test that presents participants with a more consistent task is a continually updated set of Compound Remote Associates (CRAs; [Bowden and Jung-Beeman, 2003](#)). The CRAs contains a greater number of problems than were available in the original RAT and presents participants with a more consistent task. That is, the solution word is always associated with all three words of the problem triad through formation of a compound word (or two-word phrase). For example, AGE-MILE-SAND form the compounds STONE AGE, MILESTONE, and SANDSTONE with the solution word STONE. The original set of 144 CRA problems, along with solution percentages and mean solution times by problem at different solution periods, can be found in [Bowden and Jung-Beeman \(2003\)](#). These normative data can be used in the selection of problems according to difficulty or mean time necessary for reaching a solution. Additional information has been collected about percentage of solution by insight or analysis, giving a rough indication of the 'insightfulness' of each problem.

Conclusions

As [Oltețeanu et al. \(2015, p. 2\)](#) pointed out, "Humans are capable of creativity across a wide variety of tasks and domains, including the linguistic (e.g. riddles, novels), visual (e.g. visual arts, design), auditory (e.g. musical), tactile (e.g. fashion and fabrics, texture), gustatory and olfactory (e.g. culinary creativity, perfumery), etc.," to which we should add the domain of motor skills (e.g., athletics, dance). Creativity is an inherently multivariate phenomenon that involves a variety of personality characteristics and cognitive attributes, which includes the ability to produce remote associations between concepts. Because the nature of creative processes may differ markedly from instance to instance, a truly general test of creativity must be able to assess creativity across multiple modalities, tasks and domains. This is a virtually impossible goal to achieve.

The RAT measures the ability to access words associated by co-occurrence or conceptual overlap; therefore, it depends heavily upon linguistic skills and cultural knowledge (such as colloquialisms). Not surprisingly, the RAT has failed as a general test of creativity. However, the RAT also measures the ability to access and use remotely-associated concepts at a basic level independent of language, which can come from different modalities and domains such as unusual color, texture, or taste combinations. This ability to access and use remotely-associated concepts is important for producing creative solutions in all domains. Therefore, the RAT and more recent variations of the RAT remain an important instrument for research on the basic, component processes involved in creativity, insight, and problem solving.

Since its creation, the RAT and its variations have been used to study various facets of creativity including the roles of emotion, attention, and memory, as well as the neural correlates of creativity. A recent meta-analysis of 45 studies by [Arden et al. \(2010\)](#) found that the RAT and variations on the RAT are the second most used test of creativity, following the Alternate Uses Test. Although the original goal of using the RAT as a standalone test of general creativity has not been realized, it remains a valuable and widely used tool for understanding more about the processes that underlie creativity.

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Research: Qualitative

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Introduction

Creativity reflects a unique human experience. Creative processes are nuanced and dynamic; they often depend on the individual's interpretations of a situation's opportunities and coincidences. Being creative means to transfer something inherently subjective (e.g., meanings, significances, impressions, imagination, improvisation, insight, inspiration, intuition) into an objective product (e.g., a painting, poem, piece of music, dance, solution, speech), while the assessment of product creativity in turn is based on subjective and holistic impressions. In short, creativity is a phenomenon that is essentially tied to a subjective quality.

Despite the qualitative nature of creativity, empirical studies on creativity mostly apply quantitative methodologies. In her empirical review, Long (2014) showed that empirical studies published in five prestigious creativity journals between 2003 and 2012 were predominantly quantitative. During this period, qualitative studies accounted for only 13% of the empirical studies. This neglect of qualitative studies has been persistent in each of the ten years of investigation and in all of the five considered journals. In addition, the empirical review from Kahl et al. (2009) revealed a significant decrease in the number of qualitative creativity studies within dissertations between 2005 and 2007 as compared to a sample from 1986. However, when the fact is taken seriously that many facets of creativity are subjective in nature and cannot be comprehended by using questionnaires and abstract constructs only, the bias towards quantitative methodologies is problematic. As long as the use of quantitative and qualitative methodologies is imbalanced, our understanding of creativity remains one-sided and incomplete.

In order to demonstrate the variety and potential of qualitative research, this entry describes five qualitative methodologies and discusses their relevance for creativity research. These are case studies, ethnography, phenomenology, grounded theory, and narrative studies. Although the article is not a review of qualitative studies, examples are given when presenting the methodological approaches. Before concluding remarks, general issues of validity, rigor, and ethics in qualitative research are outlined.

Foundations of Qualitative Research

Ontological and Epistemological Assumptions

Qualitative research is generally associated with specific ontological and epistemological assumptions that stand in contrast to those of quantitative research. Ontology concerns the question of what reality is; epistemology concerns the question of how to gain knowledge about reality. Ontologically, qualitative researchers assume that social reality is constructed by those involved. As there is no single reality or truth, knowledge is subjective and personal. In terms of epistemology, qualitative researchers regard themselves as a truth-shaping part of the social reality to be investigated. It is assumed that subjectivity is a necessary condition to develop an adequate understanding of a phenomenon and cannot be separated from the researcher, the participant or the situation. Scientific facts can therefore only be acquired through the researcher's interpretation of meanings within a unique social context. Qualitative research thus follows a constructivist, interpretive or postpositivist paradigm. For qualitative researchers, creativity manifests itself in each person, episode, situation or social and cultural background in a manifold and unique way. Quantitative researchers, on the other hand, follow a positivist paradigm. They assume that social reality exists independently of the researcher and is accessible to an objective investigation from an outside perspective. Scientific facts are regarded as invariable and objective. Quantitative

researchers thus assume that creativity consists of a certain amount of factors that vary among people and predict creative outcomes in a more or less reliable way. Creativity is assumed to exist independently of social, cultural and historical contexts.

The aim of qualitative and quantitative research is quite different. Qualitative research is conducted in order to gain and agree upon a holistic understanding of subjective perspectives in certain contexts. As the uniqueness of each situation is recognized, qualitative researchers do not claim that findings from a specific situation can be transferred to other situations as well. The focus is on exploration, enlightenment, awareness, and intersubjective agreement in order to develop a rich understanding regarding the meaningfulness of (creative) actions, words, events, products, places or people. The researcher is at the center of the research process, and the quality of gathering, describing and interpreting data determines the quality of the conducted research. Whereas the former are important, the researcher's primary task is interpretation, in order to discover and reveal the meanings beneath the surface. In contrast, quantitative research is mainly conducted to explain and predict a specific phenomenon in a structural manner by detecting universal laws about the causal relations of variables. Here, the focus is on the production of knowledge on how to realize a desired effect in order to predict or enhance creativity.

Method and Methodology

Although method and methodology are often treated as synonyms, both concepts have to be distinguished. Methodology refers to the general assumptions and theoretical perspectives of a study. It includes the ontological and epistemological assumptions explained above and implies a specific research design. In contrast, a method only refers to a specific research tool that is used within a methodology to collect, analyze and interpret data. The concept of methodology is therefore broader than the concept of method and guides the selection of research methods.

The three most common qualitative methods are in-depth interviews, observations and document analyses. In-depth interviews are used to elicit a comprehensive picture of the participant's perspective regarding the research object. Usually, in-depth interviews are conducted face-to-face between the researcher and the participant. They require a certain degree of openness to ensure that the participant's rather than the researcher's perspective is revealed. Although the researcher needs to specify some general topics, and in doing so pre-structures the interview, the interview process must be flexible enough to account for the interviewee's priorities and concerns. Observations are a way to collect data by watching people, events, behaviors, interactions or artifacts in their natural setting. There are non-participant and participant observations. In non-participant observations, the researcher observes the participants without directly interacting with them. In participant observations, the researcher becomes a constructive part in the site under study. Participant observation is especially suitable when the research questions can only be adequately answered through the participation of the researcher with the subjects in the setting of interest. The researcher, being both observer and participant, learns through first-hand experience. Document analysis examines documents that contain relevant information about the research question. The purpose of document analyses is to gather data on the background and historical context of the study. Examples of documents are reports, protocols, e-mails, diaries, letters, formal statements, interviews, films, videos, novels, photographs, graffiti, paintings or designs. The analysis of documents is an unobtrusive method, where the researcher is not required to intrude into the research context. In general, qualitative methods generate non-numeric (i.e. qualitative) data, as opposed to quantitative methods operating with numerical (i.e. quantitative) data.

However, for a study to be considered qualitative, it is not sufficient to apply qualitative methods. When, for example, qualitative methods are used in the stage of data collection, but the resulting categories are coded and processed numerically, the study is an example of quantitative instead of qualitative methodology. Whereas a study may apply both qualitative and quantitative methods, it cannot follow both a qualitative and a quantitative methodology in the described sense (although there is also the possibility of applying a mixed-methods research design as yet another methodological approach following a pragmatic worldview). The decisive feature of qualitative research is therefore methodology and not the methods used. For this reason, in the following qualitative methodologies are described and discussed in terms of their relevance and potential in creativity research. Following Creswell and Poth (2018), five qualitative methodologies are distinguished: case studies, phenomenology, ethnography, grounded theory and narrative research.

Overview of Qualitative Methodologies

Case Study Research

Case studies are one of the most frequently used qualitative methodologies in creativity research. In case study research, a detailed, concrete, and rich description of one particular case (single-case study) or several cases (multiple-case study) is developed with the intention of capturing the complexity and situatedness of the studied object. A case refers to a real-life, contemporary setting and serves as the main unit of analysis. In order to describe a case within certain parameters, it has to be a bounded system. A case may be bound to a specific entity (e.g., a person, partnership, group or organization) or, at a less concrete level, to a relationship, decision process, behavioral condition, event or project. Case study research is the investigation of a case over time through the use of multiple methods and information sources, including in-depth interviews (e.g., interviewing a creative genius), participant observations (e.g., being involved in the creative process) and document analyses (e.g., autobiographical records of creative individuals). The research usually begins with the identification and the definition of a specific case. Following this, it has to be decided whether the study consists of a single case or multiple cases. Whereas a single-case study focuses on the characteristics of a unique case,

a multiple-case study includes the comparison of the identified cases to discern consistent patterns or regularities. In a multiple-case design, each case is assumed to cover a complementary facet of the main research question.

Although case study research does not call for a specific theoretical foundation, the use of a theory can help to complete certain methodological steps, such as the development of the main research question, the selection of a case or the definition of case-relevant data. However, the use of a general theoretical perspective to analyze the collected data is twofold. On the one hand, it helps to organize and make sense of the collected data. In this way, a case study can attempt to extend or challenge a theoretical perspective. On the other hand, such a perspective can also limit the ability to make discoveries that are beyond the theoretical scope.

The literature provides a number of examples using case study methodology to identify the main characteristics of (eminent) creative persons and to develop a rich understanding of their creative processes and the resulting products. A famous example of a multiple-case study in creativity research is Howard Gardner's book *Creating Minds*. Gardner compared and contrasted the lives of seven eminent individuals who made highly creative contributions in the 20th century: Sigmund Freud, Albert Einstein, Pablo Picasso, Igor Stravinsky, T. S. Eliot, Martha Graham, and Mohandas Gandhi. He showed that creativity is a domain-specific phenomenon that embodies different forms of intelligence: interpersonal intelligence (Freud), logical-mathematical intelligence (Einstein), spatial intelligence (Picasso), musical intelligence (Stravinsky), linguistic intelligence (Eliot), bodily-kinesthetic intelligence (Graham), and intrapersonal intelligence (Gandhi). Despite this divergence, Gardner also showed that these individuals shared specific developmental experiences and dispositional traits. For example, all showed a high level of self-absorption in their activities.

A theoretically based approach to use case studies in creativity research is Howard E. Gruber's evolving systems approach (ESA). ESA is designed to develop an in-depth understanding of the uniqueness of the individual creative person at work. It assumes that each person's purpose, affect, and knowledge evolve over time, lead to individually different paths and result in unique creative products. Purpose, affect, and knowledge are used as major subsystems to structure cases of creative individuals to depict unique attributes. The groundwork of Gruber's approach for the case study of evolving systems was his work on Charles Darwin. Furthermore, ESA has been applied to study the life and works of Albert Einstein and Michael Faraday, among others (See Evolving Systems Approach).

In creativity research, case study methodology is not restricted to investigating extraordinary or eminent creativity, but can also be used to understand everyday creativity. For example, several studies have been conducted to explore individual or collective problem solving in organizational or educational settings. [Crompton and Crompton \(2008\)](#) analyzed the problem solving behavior of engineering students to illustrate the application of universal indicators of creativity in a specific domain. Case studies are also suitable for cases of gifted children and adolescents.

Ethnographic Research

Ethnographic methodology is rooted in anthropology. The intent is not to explore a single case, but to develop an in-depth understanding of individuals, processes, products or environments in different cultures. The term culture refers to a system of synthesized facts, experiences and traditions that altogether constitute a coherent worldview. The ethnographic researcher analyzes and interprets the shared and learned patterns of meaning, values, beliefs, behavior and language among the members of a culture-sharing group. The culture-sharing group thus serves as the main unit of analysis. To be considered as a culture-sharing group, the group must have been interacting long enough to develop a common identity and shared patterns of interaction. A cultural group may be small (e.g., a few artists working together), but typically refers to a larger amount of individuals who interact in a specific cultural context over time (e.g., a community of artists or teachers in an art school). Although interviews and document analyses are relevant sources, ethnographic research particularly involves extended participant observations of the group, in which the researcher is immersed to gain insights from a first person's perspective. The research process in ethnography is essentially based on a theoretical perspective that guides the researcher's attention towards a specific direction. This need for a theory distinguishes ethnography from other qualitative methodologies.

The central assumption of the ethnographic approach to creativity is that sociocultural contexts determine and influence creative behavior, whereas at the same time creative behavior shapes culture and society. Ethnographic studies can help to develop a holistic understanding and interpretation of creative individuals, processes, products or environments and their reciprocal relationships within a specific cultural context. Examples of research questions are: In which way does the creative individual, product or environment determine the creative process? How do cultural values and beliefs shape perceptions about the creativity ascribed to products? Does culture enhance or inhibit the unfolding of creative processes in a specific way? A suitable theory has to be selected, depending on which research question is to be answered.

The theoretical foundations of an ethnographic study of creativity may be diverse. However, three theoretical approaches seem particularly suitable in this context: Mihaly Csikszentmihalyi's systems model of creativity, Pierre Bourdieu's theory of cultural production, and Vlad Petre Glăveanu's Five A's Framework. According to the systems model of creativity, the creative environment consists of the cultural system (the domain) and the social system (the field). The domain is a culturally defined symbolic system (e.g., the periodic table in chemistry, musical notations in music, mathematical notation in mathematics), the field consists of people who influence a domain (e.g., publishing houses, art critics, scientific communities). Creativity is conceptualized as a process that occurs through the interaction of individuals, domains, and fields. An individual draws on a set of rules and practices from the domain to produce a novel variation in the content of the domain. This novel variation is selected by the field for inclusion into the

domain. Creativity only occurs when an individual makes a change in a domain through the selection of the field. From this perspective, creativity can only be understood in the context of culture (See Systems Approach).

In his ethnographic field work, Bourdieu demonstrated that creativity emerges from the complex interplay between a field of works (as a cultural-sharing group) and the individual's habitus. The field of work pre-structures possibilities and restraints of action, and the individual's schemes of action and perception (= habitus) determines how well the field's demands of action can be fulfilled (Bourdieu, 1996).

The Five A's framework also follows a sociocultural, systemic perspective and integrates the concepts of actor, action, artifact, audience, and affordances (as the Five A's) into a coherent framework, whereas it is a defining feature of the framework that none of the Five A's can be investigated in isolation. For example, the actor only exists in relation to an audience, and action is always embedded in a social and material world. The inclusive character of the framework is mirrored in the given definition of creativity: "Creativity is concerned with the action of an actor or group of actors, in its constant interaction with multiple audiences and the affordances of the material world, leading to the generation of new and useful artifacts" (Glăveanu, 2013, p. 76).

Although the importance of ethnographic studies is often stressed in creativity research, the methodology is rarely used. As one of the few examples, McIntyre (2008) ethnographically studied contemporary Western popular music songwriting. The study was based on Csíkszentmihályi's systems model, which was partially coupled with Bourdieu's approach. It concluded that knowledge of the domain of contemporary Western popular music, as well as the access to the field that holds this knowledge, is crucial for a songwriter to be (and count as) creative.

In the end, creativity is in the eye of the beholder, and different culture-sharing groups may vary in their patterns of perception and evaluation of creativity. The ethnographic approach is thus of high relevance for creativity research, and despite its rare use there is a growing interest in culture and society within creativity research. Besides sociocultural studies, cross-cultural studies are also of great interest. Contrasting Western and non-Western cultures, ethnographic studies may help to overcome the prevalent ethnocentric character of creativity research and to identify similarities and differences of creativity between them.

Phenomenological Research

In general, phenomenology is the study of phenomena. It is a qualitative methodology, which initially carries out observations and draws conclusions from them in order to acquire category systems that permit a phenomenon to be named and described. Phenomenological methodology focuses on the subjective, experiential, lived aspect of a particular phenomenon. A phenomenon can be defined as a state of affairs whose factuality appears to someone at a specific time to be unchangeable even with an arbitrary variation of all possible assumptions, and imposes itself on him in such a way that he or she is unable to deny its existence seriously. An example of a creativity-related phenomenon is the flow experience, which was introduced to creativity research by Mihaly Csíkszentmihályi. Flow describes the pleasuring experience of being fully immersed in a specific activity, associated with a feeling of energized focus and full involvement (See Flow). Although phenomenology concerns subjective experiences, the aim is to explore the common meaning for several individuals of their experience of a specific phenomenon by reducing various subjective experiences to an understanding of their universal essence, to make explicit the implicit structure of human experience. The phenomenologist uses a variety of qualitative methods to collect data from individuals who experience or have experienced a specific phenomenon, in order to derive essential structures of subjective experience. Typical data sources are experiential reports in written form, or in-depth interviews.

Phenomenological methodology is well-suited for research into the creative process, because the latter represents a significant and unique human experience. The creative process, as a phenomenon, has been described by eminent individuals in extremely different domains, including natural sciences, literature, painting, and music. Famous phenomenological depictions of the creative process stem from Hermann von Helmholtz and Henri Poincaré, based on which Graham Wallas formalized the four-stage model of the creative process (i.e. preparation, incubation, illumination, verification). Besides studying experiential reports of eminent individuals, phenomenological studies in creativity research often use in-depth interviews. For example, Nelson and Rawlings (2007) conducted semi-structured interviews to explore the creative process of eleven artists. They detected several recurring themes such as the sense of recognition of emerging structures in the artwork or the prominent role of intuition. Beside the creative process, the phenomenological approach can also be applied to study the experience of a creative product as valuable, fascinating and/or unique. For example, the aesthetic experience of admiring artwork, enjoying a piece of music, being fascinated by a dance performance or applying a creative solution represent discrete phenomena that are accessible through phenomenological inquiry.

Phenomenological methodology requires suspending all judgments about reality until they are founded on an experiential basis. Edmund Husserl called this process of suspended judgment *epoché*, which represents a general predisposition one must assume before conducting phenomenological research. Hence, a theoretical basis is not needed for phenomenological inquiries. However, phenomenology has a strong philosophical component, and phenomenological studies can as well be theoretically based on phenomenological works of philosophers such as Edmund Husserl, Max Scheler, Martin Heidegger, Alfred Schütz, Jean-Paul Sartre, Maurice Merleau-Ponty or Hermann Schmitz. Bindeman's study (1998), for example, analyzed inherent characteristics of the different stages within the process of creativity, as described by eminent creative individuals such as Henri Poincaré or Pablo Picasso on the basis of Husserl's phenomenological studies. Julmi and Scherm (2015) applied insights from the phenomenology of Schmitz to suggest that creativity is a domain-specific ability with three different domains on the uppermost level: corporeal creativity as the ability to present atmospheres (e.g., music, painting, dance), hermeneutical creativity as the ability to adapt to and create

situations (e.g., writing, interpersonal relationships), and analytical creativity as the ability to deal with constellations (e.g., math, science). Such conceptions may serve as a theoretical perspective for phenomenological inquiries to dig further into the subjective experience of creativity.

Grounded Theory Research

Like phenomenology, grounded theory methodology focuses on the study of the individual's lived experience in the natural setting and emphasizes the need for an open inquiry. The difference is that phenomenology seeks to understand a phenomenon's essence, whereas the aim of grounded theory is to generate or discover a theory for a (creative) process or action. [Strauss and Corbin \(1994\)](#) defined grounded theory as "a general methodology for developing theory that is grounded in data systematically gathered and analyzed. Theory evolves during actual research, and it does this through continuous interplay between analysis and data collection" (p. 273). The aim of grounded theory is to develop a theory that is "grounded" in the lived experience of the studied process or action, and therefore is tailored to the research object.

Because the result of grounded theory is a theory, the research process itself cannot be based on a theoretical perspective. Instead, the researcher writes down memos as data is collected and analyzed in order to formulate the process from the researcher's point of view (memoing). Data collection, data analysis and memoing are supposed to be undertaken simultaneously and iteratively, going back and forth between collecting data and refining the theory. The research process includes open coding, axial coding, and selective coding. Open coding refers to the identification and labeling of the data in order to build data categories. Axial coding is a comparative process in which data categories are related to one another in order to detect causal relationships. Selective coding is the procedure of choosing one category to be the main category and systematically relating it to the other categories. The resulting theory can be presented as a diagram, propositions, hypotheses, a discussion or, when the research process is less structured, a conjunction of implicit meanings about a category.

Similar to phenomenology, grounded theory methodology is especially valuable for the generation or discovery of theories regarding the creative process. Although the number of grounded theory studies in creativity research is relatively small, the approach seems to increasingly attract scholars from various creativity-related fields. For instance, [Mace and Ward \(2002\)](#) used grounded theory methodology to develop a complex descriptive model of the art-making process from the initial stages of idea inception through to the resolution of the artwork. One finding was that problem solving is a component within the art-making process rather than something the artist is working towards as such. Similarly, [Sawyer \(2018\)](#) developed a grounded theory of the art-making process that revealed the creative process to be wandering, unpredictable, non-linear, and embedded in the physical act of generating work. [Tracey and Hutchinson \(2018\)](#) developed a grounded theory on written reflections produced by graduate students in learning design in response to several prompts on uncertainty. They found that students experience uncertainty as an influence on personal agency, that uncertainty is perceived to provoke complex, ambivalent emotional responses, and that students identify both internal and external strategies for managing uncertainty.

Narrative Research

Narrative research is an umbrella term encompassing methodologies that rely on spoken or written words. Narrative research usually focuses on one or two individuals. The aim is to tell a story of individual experiences through the identification and interpretation of patterns of meaning. This form of research explores expressed experiences in lived and told stories of individuals. As narratives always occur within specific situations, narrative research also tries to consider the social and cultural narratives in which individual experiences take place. Stories, as the main unit of analysis, are gathered through various data sources. The research design typically involves interviews with participants. Stories can be told directly, but often emerge as a co-construction through the interaction of the researcher and the participant. Narrative stories are also gathered through observation or document analysis. The collected stories are often structured chronologically, emphasizing momentous incidents or turning points. The analysis of the story depends on the narrative strategy. For example, a story can be analyzed thematically (what is the story about?), dialogically (who is the story for?), or by focusing on specific values, plots or characters.

Regarding the creative process, narrative studies can enhance our understanding on how individuals frame, recall, and report their creative experiences within a certain social and cultural context. The interpretation of narratives can help to explore the meanings individuals ascribe to the experience of creativity, and how these meanings are related to a greater context. Recently, [Chakraborty \(2017\)](#) highlighted the potential of narratives for conducting research into the creative process: "While narrating their stories, the participants piece together fragments from their working lives to add sense to their stories and thus provide scope to widen the researcher's interpretation of the creative process" (p. 2965). Nevertheless and despite their potential, to date there are virtually no narrative studies in the field of creativity research. As a notable example, [McAdams and Logan \(2006\)](#) examined the question of how eminent creative academics narrate their professional and personal lives, concluding that "people find meaning and purpose in their lives through the construction, internalization, and constant revision of life narratives" (p. 106).

An interesting approach that combines elements from ethnographic and narrative research is autoethnography. In autoethnography, the researcher describes and analyzes his or her own narratives in order to understand culturally shaped experiences. The researcher retroactively and autobiographically writes about meaningfulness experiences from the past (e.g., epiphanies, existential crises, or extraordinary encounters) and contrasts them with similar experiences from other people and/or existing research. In this

way, the researcher helps to better understand cultural patterns of meaning, values, beliefs and behavior for both insiders and outsiders. Autoethnography is not only itself a creative practice, but is also suitable for studying creative practices in a cultural context.

Issues in Qualitative Research

The fact that qualitative research mainly relies on interpretations both of the researcher and the participant raises at least three concerns: research validity, research rigor, and research ethics.

In terms of research validity, qualitative research is not judged by strict standards such as those applied in quantitative research. The demand for generalizability is not adequate for qualitative research and distracts from its purpose. For example, methodologies such as case studies focus on contextual uniqueness and are not designed to be replicated. Validity in one context does not imply validity in another context. Instead, it is argued that qualitative research should be judged using different criteria such as credibility, transferability, dependability, and confirmability. However, such criteria are themselves disputed. Some scholars even reject the idea of research validity in qualitative studies. They argue that if it is ontologically assumed that there is no single external reality, it would be inconsistent to be concerned with the truth or falsity of qualitative results with respect to such a reality.

Regarding research rigor, ontological and epistemological assumptions have to be discussed and made transparent by the researcher. In terms of methods applied, it is assumed that relying on one source of data is not sufficient to develop a holistic understanding of a particular phenomenon. Where possible, interviews, observations and document analyses should be combined. The process of gathering data in multiple ways relying on multiple sources is called triangulation. The discussion of results with other researchers helps to strengthen the derived conclusions and to consider different points of view. Notes, memos, documents, and so forth, should be made available to other researchers to reconstruct the research process and to verify that research was conducted in an acceptable manner. In all of this, however, it must not be forgotten that creativity research is itself a creative practice. The traceability of the research process is therefore limited.

Last but not least, there are several ethical issues that need consideration. First, the rights and permissions of the participants must be protected, and their permission to conduct the study must be obtained. The privacy and concerns of the participants should be treated with respect. Second, the researcher must be honest, and the relationship between researcher and participants should be based on mutual trust (which also determines the quality of the data). The intents, requirements, and risks of the study should be transparent to the participants at all stages of the research process. Third, the researcher is obliged to take up a nonjudgmental attitude to avoid stereotyping. Finally, as participants usually sacrifice their free time for the study, the researcher should give something in return. Sharing the results with the participants is mandatory.

Concluding Remarks

Definitions of creativity often focus on the creative product as the outcome of the creative process. As Sawyer (2012) pointed out, there is a growing interest in a sociocultural definition of creativity, according to which creativity “is the generation of a product that is judged to be novel and also to be appropriate, useful, or valuable by a suitably knowledgeable social group” (p. 8). Products are never creative as such; they have to be labeled creative by someone, and the way in which creativity is understood determines how individuals engage in the creative process. Hence, creativity is a (socially) constructed concept that can only be adequately understood by considering its unique social, cultural and historical context.

As the creative process is inherently subjective, it is not surprising that qualitative methodologies are especially well-suited for exploring the creative process. Although some scholars may refer to quantitative methodologies as the gold standard of approaching creativity, such a view is misleading, because quantitative and qualitative methodologies are complements rather than substitutes for the development of a comprehensive and multifaceted picture of creativity. Given the strong relevance of subjective experiences for the understanding of creativity, the prevalent dominance of quantitative methodologies is not acceptable. This overview will hopefully encourage scholars in creativity research to engage in qualitative research. As the selection of an appropriate methodology to study the creative process is driven by the interest of the researcher, the explication of five methodologies and their relevance for creativity may help the process of selecting a specific methodology.

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Resilience and Adaptation

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Two Key Overlapping Concepts: Resilience and Self-regulation

Engaging in the creative process is often viewed as an expression of resilience (McFadden and Basting, 2010). Individuals who respond to adversity with attentional flexibility, while accessing effective problem solving skills are deemed resilient during the adverse event. In the aftermath, generating creative solutions to restore balance within the individual and community are also factors of resilience. Despite exposure to traumatic events, resilient individuals exhibit the quintessential ingredients of creativity; they manifest novel and valuable approaches to remedy the traumatic event and find meaning and purpose in the days and years following the traumatic event. This behavioral trajectory was identified in a longitudinal study of Holocaust survivors; resilient survivors engaged in creative expression during the holocaust and this creative output persisted throughout their lives (Corley, 2010). In this chapter, resilience and other associated terms, concepts, and models are defined. Psychological, neurobiological, and physiologic factors that promote resilience are outlined, including ways to enhance resilience.

The terms resilience and self-regulation are often employed interchangeably; although resilience is generally regarded as a more specific and narrowly defined term. Self-regulation describes an overarching concept of adaptation throughout life. It describes the ability to adapt to changing environments while sustaining goal directed behaviors. Physiologic self-regulation typically operates outside of conscious awareness, whereas psychological self-regulation is mobilized by a conscious sense of self (Bonanno, 2004). Physiologic and psychological regulation strategies are influenced by dispositional traits. The temperament of an individual will shape the level of reactivity to stimuli and will provoke behaviors that are either withdrawing (inhibitory) or approaching. During development, temperamental disposition shapes self-regulation; however, the need to respond to challenging situations varies amongst individuals. Maturation into adulthood necessitates that more complex strategies are learned and mobilized beyond basic approach or withdrawal impulses.

Resilience refers to individual efforts to achieve good outcomes despite serious threats to adaptation or development (Bonanno, 2004). For example, most children demonstrate incredible resilience throughout development, including acquiring competent skills to meet the demands placed on them. Similarly, most adults are equally able to function despite exposure to traumatic events. When measuring resilience, individuals must first be exposed to adverse events that threaten physiologic and/or psychological stability (Kaye-Tzadok and Davidson-Arad, 2016). They must remain stable across multiple domains of functioning (biological, emotional, educational, social, workplace). Assessing resilience must include a complex interaction of psychosocial and biological factors that are mobilized to resist the negative effects of adversity (Kaye-Tzadok and Davidson-Arad, 2016). Resilient individuals may initially feel overwhelmed during a traumatic event or significant loss, but they are able to function despite feelings of horror or grief. They do not exhibit maladaptive behaviors such as substance abuse, absenteeism, homelessness, or violence. As well, they do not manifest any psychiatric disorders and they are able to maintain good health despite enduring extreme stress (McGloin and Widom, 2001).

Individuals who falter in stressful situations and then recover, or even grow from these experiences later (posttraumatic growth), are not regarded as resilient (Bonanno, 2004). Across research studies, one major limitation when classifying individuals as resilient versus recovered is the inconsistent criteria to determine a history of adversity (Kaye-Tzadok and Davidson-Arad, 2016). For example, grouping individuals after a natural disaster into classifications of resilient, recovered, or suffering PTSD fails to account for prior exposure to traumatic events and the cumulative effects of trauma. An individual who developed in a community that was fraught with poverty, violence, loss, and broken family structures may respond to traumatic events very differently compared to an individual who was raised in a high socio-economic community, with no exposure to violence, and raised in a stable family structure (Hobfoll et al., 2009). Studies demonstrate that less resources, including lack of support from friends

and families, increase the odds that an individual will experience traumatic symptoms, and for a more protracted time, than individuals with more resources. They will not be classified as resilient despite the reality that under less oppressive circumstances they may have manifested resilience (Hobfoll et al., 2009). Despite exposure to cumulative trauma, other factors may promote resilience, such as strength gained from a strong ethnic identity and affiliation with church groups, the arts, or sports (Kaye-Tzadok and Davidson-Arad, 2016). Recent research is now demonstrating that creative engagement is equally important in promoting resilience (McFadden and Basting, 2010). These socio-economic and creative variables directly influence prevalence rates for resilience across studies.

Personality Traits: Hardiness, Grit, and Autotelic Personalities

Hardiness, grit, and autotelic personality are considered inherent traits within an individual; these traits are less driven by psychosocial behaviors. An individual who is described as hardy tends to demonstrate attitudes of commitment and control; they actively seek challenges (Sheard, 2009). They thrive in situations that involve stress and high risk. Hardiness implies that an individual is endowed with superior abilities and is able to meet adversity with success. Although hardy individuals manifest robust physical and psychological strength, they are not immune to illness and disease; however, even when sick they display attitudes and behaviors of control and commitment. Hardy individuals are generally task-oriented and maintain an abiding faith that they can sufficiently manage any situation (Sheard, 2009).

Grit is a concept developed by Angela Duckworth; she observed that long-term goals are often achieved as a consequence of perseverance and passion. Grit is a personality trait that operates beyond the Big Five personality trait of conscientiousness (Duckworth and Quinn, 2009). According to Grit Theory, beyond individual talent and aptitude, persistence and passion strongly predict goal achievement. Even under adversity, individuals who possess grit are more likely to display traits of resilience. Although grit is often examined as a separate factor, cultivating a courageous mindset reinforces efforts to persevere and reduces fear behavior. Courage, like grit, integrates self-reflection and positive beliefs about goal-achieving abilities (Hannah et al., 2007).

According to Csikszentmihalyi (1996), individuals who possess an autotelic personality demonstrate significant resilience under challenging situations. It is a genetically heritable personality trait. Specifically, autotelic individuals possess low neuroticism and high conscientiousness and these traits are amplified in environmental conditions that promote flow-engendering activities (Csikszentmihalyi, 1996). Autotelic individuals have confidence and optimism; they believe that they will not only succeed but also achieve optimal performance states in work and academic settings (Csikszentmihalyi, 1996). They demonstrate personal innovativeness, self-efficacy, and enhanced perceptions of control. Possessing an autotelic personality is also associated with increased health-related quality of life, sense of fulfillment, positive emotions, goal-directedness, and efficient time management (Csikszentmihalyi, 1996). Autotelic personality traits enhance resilience, creative flexibility, and life satisfaction.

Models of Self-regulation and Resilience

There are multiple models that describe self-regulation and resilience. These models offer concepts that capture how an individual may remain resilient despite extreme exposure to adversity (Benight, 2012).

1. Salutogenic Model: Views health and disease on a continuum and reinforces the need to examine protective factors as well as risk factors.
2. Social-Cognitive Theory: A bi-directional theory that includes interactive responses between the environment, person, and behavior (i.e., self-efficacy).
3. Self-Regulation Shift Theory: Builds on the social-cognitive theory and elaborates on dynamic state shifts that provoke destabilization and re-organization.
4. Terror Management Theory: Based on the concept of death-anxiety and ways to manage daily life despite the inevitable reality of death.
5. Transactional Theory of Stress and Coping: The interaction between the environment and a stressful situation reveals physiologic responses, cognitive processes, and coping strategies that are employed to manage stress.
6. Conservation of Resources Theory: This theory examines the losses (finances, employment, home, health, family) that are experienced during stressful situations and how individuals falter or thrive.
7. Social Support Theory: Support from family, friends, community, and/or workplace provides a sense of belonging that buffers the potential loneliness and isolation associated with trauma and loss experiences.
8. Attachment Theory: Early attachment relationships with primary caregivers are internalized and influence a lifetime trajectory of behaviors and states of mind regarding attachment, trauma, and loss experiences.
9. Information Processing Theories of Trauma Responses: Theory that delineates how traumatic responses, both cognitive and emotional processes, involve assimilation and accommodation.
10. Stress-Diathesis Model: Biological genetic predispositions influence vulnerability and resilience under stress.
11. Kindling Theory: A neurobiological theory that describes allostasis and allostatic loading associated with cumulative trauma exposure.

Resilience Factors

Factors that operate as protection from adversity are considered components of resilience. A major resilience factor is early secure attachment experiences. Secure attachment promotes the development of self-regulation skills, positive beliefs about oneself, and intrinsic motivation to succeed in multiple settings (i.e., academic, sport, arts, social) (Moltafet et al., 2018). Children who receive sensitive, attuned parenting from their caregivers internalize optimal emotion regulation coping strategies. Although they are less likely to suffer maltreatment by their caregivers, they may still be raised in adversity, including exposure to domestic violence, family mental illness, substance abuse, incarceration, or the death of a parent. With the early formation of secure attachment, despite adversity, these children are more likely to manifest resilience compared to children classified with insecure attachment (Moltafet et al., 2018). Attachment insecurity is significantly associated with harsh parenting and the persistence of emotional dysregulation in adulthood. Adults with insecure attachment histories have higher risk for disease and mental illness, and they lack the psychological resilience to tolerate pain, including chronic pain (Ogle et al., 2015).

Another major factor that promotes resilience is the perceived ability to access resources. Social support augments adaptation skills, especially under stress. For children, adolescents, and adults, a history of secure attachment promotes the perception that other people are reliable and dependable (Ogle et al., 2015). A sense of self is nurtured in these secure attachment experiences, including a sense of autonomy, self-efficacy, safety, and a positive belief in others (Moltafet et al., 2018). Insecurely attached individuals often draw less comfort from others and do not perceive social support as a resource under stressful situations. A positive perception regarding resource acquisition also promotes a sense of optimism, a trait that enhances resilience. Specifically, optimistic individuals generate positive imagery about the outcome of stressful and traumatic events, which reinforces their resilience (Blackwell et al., 2013).

Creativity is increasingly included as a factor that promotes resilience; in fact, creative engagement is regarded as an expression of resilience (McFadden and Basting, 2010). For example, creative engagement has a neuroprotective effect in older adults. It promotes memory retention and enhances cognitive capacities. Studies on resilience and aging suggest that engaging in creativity slows the natural effects of aging (McFadden and Basting, 2010). In a study on resilient holocaust survivors, creative engagement throughout their lives was a significant protective factor (Corley, 2010). In this study, creative expression had the potential to increase personal and community wellbeing for these survivors. Similarly, creativity was listed as one of the key factors in communities that demonstrated social resilience during and following a major disaster. Remaining creatively engaged enabled the community to effectively manage emergencies and implement new or modified prosocial policies (Kaye-Tzadok and Davidson-Arad, 2016).

Neurological and Physiologic Factors in Resilience

Stress is a natural biological factor in all life forms. Neurophysiological responses to stressful demands may be adaptive or maladaptive; these micro and macro biological system responses determine individual levels of biological resilience. Research studies demonstrate that greater physiologic variance is associated with more resilience, especially when examining the physiologic rate of recovery following a stressor (Razumnikova et al., 2013).

Attachment experiences, both positive and negative, shape resilience or risk responses in adulthood via a complex gene-environment interaction (Gillespie et al., 2009). Attachment experiences mediate polymorphism changes to two key genes, CRHR1 and FKBP5. These genes determine resilient or maladaptive reactivity of the amygdala-hypothalamus-pituitary-adrenal (HPA) axis. As well, increased levels of neuropeptide Y (NPY), oxytocin, and endogenous opioids have been linked with resilience (Gillespie et al., 2009). These neuropeptides are integral components of the HPA axis, as well as the autonomic nervous system and the hippocampus. Individuals with higher levels exhibit more empathic abilities as well as fewer symptoms of stress after exposure to a traumatic event. Even children with high childhood adversity exposure are actually able to enhance cognitive and executive functioning processes when they have elevated levels of NPY and oxytocin (Gillespie et al., 2009). These and other study findings reinforce a direct relationship with optimal genetic heritability. In particular, early caregiving directly influences genetic expression; sensitive (responsive parents) or hostile (unresponsive parents) parenting shape positive or negative childhood gene-environment interactions (van Ryzin et al., 2015).

Posttraumatic Stress and Growth

The term posttraumatic growth was coined to describe a different trajectory in individuals not classified as resilient. It identifies individuals who not only recover from PTSD but also gain a stronger sense of self after recovery. These individuals, who manifest traumatic symptoms following exposure to trauma, are able to attain a positive transformation once the traumatic symptoms abate. Posttraumatic growth factors include an ability to relate to others, a willingness to explore new possibilities, a growing sense of personal strength, transformational spiritual experiences that shift perceptual orientations, and an increased awareness that life is valued and appreciated (Kaye-Tzadok and Davidson-Arad, 2016). Anger also facilitates posttraumatic growth; it can mobilize efforts to change conditions, especially after prolonged exposure to violence. Individuals may endorse one or several of these factors when they describe how they achieved posttraumatic growth (Kaye-Tzadok and Davidson-Arad, 2016). This growth may be sustained throughout a lifetime or be transient. Transient posttraumatic growth is often due to subsequent stressors that occur

throughout the lifespan. Whether transient or persistent, experiencing posttraumatic growth often increases a renewed sense of purpose, meaning, and creativity, regardless of the presence of trauma-related symptoms (Kaye-Tzadok and Davidson-Arad, 2016; Thomson and Jaque, 2018).

Resilience and Creativity

Engaging in creativity and gaining opportunities to master skills, realize talents, and interact in environments that provide social support, all enhance resilience, especially during stressful times (Lee et al., 2016). Children, adolescents, and adults are able to draw upon these positive factors and sustain a sense of autonomy and efficacy. After exposure to a traumatic event, resilience is enhanced when individuals can find meaning in these experiences; in particular, they have an ability to internalize the trauma into a global belief in a world order that contains fairness and an awareness of self-directed and other-directed compassion (Gan et al., 2018). These meaning-making processes enable individuals to find benefits and positive experiences from their exposure to life-threatening events. These experiences can be incorporated into creative activities, and directly or indirectly influence individual creative expression.

Creativity is often associated with talent or giftedness (see Giftedness). Typically, children who are gifted or possess domain-specific talents are often vulnerable to more intense responses to challenges, including more obsessive behaviors while engaging in problem solving tasks. They are more sensitive to environmental stimuli and this is intensified when they are exposed to traumatic events. Their negative reactions increase in adverse childhood environments, which has been associated with a reduction in their ability to realize their creative potential (Knezevic and Ovsenik, 2002). Highly gifted/talented children must acquire psychological skills to manage their emotional and physical intensity as well as ways to regulate anxiety and obsessive behaviors; this is even more relevant for traumatized gifted children. Acquiring these self-regulating skills may enhance creative flexibility and promote more psychological resilience (Gan et al., 2018; Moltafet et al., 2018). As noted by Frank Barron, some highly creative people are extremely vulnerable to mental illness whereas others remain stable and well regulated. These different outcomes may be related to innate resilience factors, or the lack thereof. Despite this variance, studies demonstrate that highly creative individuals tend to recover faster physiologically after a stressor compared to less creative individuals, which suggests that creativity may be a resilience factor (Razumnikova et al., 2013).

The ability to conjure imaginary companions or paracosms (complex imaginary worlds that are elaborated and cultivated over a protracted period of time) is associated with resilience (Aguilar et al., 2017). Imaginary companions provide positive resources including reducing boredom, increasing entertainment, friendship, and social support, especially for children who are placed in foster care after exposure to maltreatment (Aguilar et al., 2017) (see Imagination). Paranormal experiences are also heightened in many maltreated children. Their desire to feel a connection with a power beyond human dimensions and to imagine that they possess supernatural powers provides an antidote to the abuse and neglect they suffer. In all cases, imaginative engagement may provide a sanctuary when exposed to adversity and maltreatment (Corley, 2010).

Another marker of resilience is the ability to intensify or suppress emotional expression in order to optimize responses under stressful conditions (Bonanno et al., 2004). Regulating emotional intensity under stress is also associated with creative expression, especially for individuals working in the performing arts (Thomson and Jaque, 2018). Likewise, emotional responses to traumatic events directly influence the degree of distress as well as positive or negative perceptions about the traumatic event. For example, following the terrorist attacks on September 11th, 2001, even though the dominant feelings of fear, anger, and sadness prevailed, individuals who also displayed positive emotions such as gratitude, love, and hope demonstrated more psychological resilience (Fredrickson, 2004). They were psychologically protected and did not develop anxiety and depressive disorders in the aftermath of this event (Fredrickson, 2004). These findings reinforce the broaden-and-build model of adaptive coping, which posits that the positive emotions influence broader cognitive appraisals from which creative problem solving strategies can be built (Fredrickson, 2004).

Resilience is also evident in the workplace, especially in industries that are typically more turbulent. More resilient industries have greater creative output (Richtner and Lofsten, 2014). It is recommended that managers reinforce the “soft” skills in organizations such as supporting cognitive, emotional, and structural resources; by enhancing these resources resilience and organizational creativity is promoted (Richtner and Lofsten, 2014).

Key factors that promote resilience and creativity are the provision of authentic leadership and encouraging employee psychological capital in the workplace (Marwa and Milner, 2013). The components of psychological capital include efficacy, hope, and resilience; they all positively enhance creative performance. Both authenticity and psychological capital are strongly evident in entrepreneurial groups, especially groups that have the capacity to rebound from adversity and display even more strength, commitment, and resources (Marwa and Milner, 2013). These factors, and in particular, creative engagement, are currently regarded as essential components in all industrial and corporate sustainability efforts. Large organizations are now encouraging creative efforts to promote corporate sustainability and employee psychological capital.

Conclusion

Resilient individuals respond to adversity with a sense of purpose and optimism. In the face of trauma, they sustain cognitive beliefs that solutions can be found and that their efforts have meaning. Ultimately, the concept of resilience is an interactive concept; an

individual assessment must include factors such as genetic inheritance, environmental risks, and lifespan trajectory. The majority of individuals exposed to trauma respond with resilience; however, a much smaller proportion of severely maltreated children (22%) are deemed resilient (McGloin and Widom, 2001). Early traumatic exposure, polyvictimization, cumulative trauma, and biological constraints may erode innate resilience abilities (McGloin and Widom, 2001). In adulthood, these severely maltreated individuals may once again restore their capacity for resilience via increased social support, adequate economic resources, and diminished adversity (Lee et al., 2016).

The relationship between resilience and creativity is strong; in particular, both require cognitive and emotional flexibility. One significant factor that promotes both is experiencing early warm parental care compared to unstructured chaotic parenting (Moltafet et al., 2018). Higher childhood exposure to trauma may not always compromise wellbeing; study findings demonstrate that some individuals may increase achievement and optimize performance as well as derive greater meaning and healing while engaging in the creative process (Thomson and Jaque, 2018). In fact, educational programs that develop creativity, rather than merely allowing creative opportunities, not only enhance creative skills such as solving problems, frustration tolerance, and persistent exploratory behavior, but they also cultivate skills that enhance resilience (Gan et al., 2018; Corley, 2010). This was also evident in a study that investigated resilience in refugees and asylum seekers. Programs that encouraged regular creative engagement enhanced resilience in the refugees and asylum seekers (Gan et al., 2018). In addition, careers that require creative expression promote greater happiness, sense of autonomy, and job satisfaction; all factors that may foster greater resilience in the face of adversity (Bille et al., 2013). Growing empirical evidence now suggests that creativity may be an integral component in resilience.

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Rewards

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The scholarly history of rewards and creativity is long and complicated. Over the past six decades, hundreds of studies have examined the effect of rewards, praise, recognition, salary increases, and prizes, on creativity of diverse types, music, writing, and art, and in diverse contexts, schools and work organizations. Early research often aimed to answer a rather simple question: Do rewards help—or hinder—creativity? Later research has taken a more complex view of the rewards–creativity relationship to consider when and how rewards may differentially affect creativity.

This entry looks back at the controversial and inconsistent findings surrounding the reward–creativity relationship. First, there is a brief overview of two dominant theoretical perspectives traditionally used to explain how rewards may affect performance on creative tasks and examine more contemporary perspectives of the rewards–creativity relationship. Second, the findings of a large-scale meta-analysis that quantitatively synthesized studies that examined the rewards–creativity relationship are presented ([Byron and Khazanchi, 2012](#)). Third, a review of more recent research examining how rewards affect creativity—and whether aspects of the person or situation present important contingencies of this relationship. Finally, a discussion of future research and the possible impacts of not rewarding creativity.

Theoretical Approaches Linking Rewards and Creativity

In earlier research, scholars considering the effects of rewards on creativity generally relied on one of two opposing theoretical perspectives—a behavioral approach or a cognitive approach. Both these broad approaches to motivation will be reviewed and then more contemporary theoretical approaches that consider the role of rewards on creativity will be discussed.

Advanced in the early 20th century by John B. Watson and B.F. Skinner, the behavioral approach suggests that people learn and modify their behavior based on the consequences associated with their behavior. People develop contingent associations between what they do and the consequences of the behavior, and these associations motivate future behavior. In relation to the reward–creativity relationship, scholars who used this approach relied on motivational theories to argue that people respond to the promise of or receipt of rewards with increased creative performance. They argue that people will be more creative when valued rewards are offered or received. According to scholars using this approach, creativity is like any other behavior; it responds to operant conditioning and will be repeated when rewards are positive. Learned industriousness theory ([Eisenberger, 1992](#)) and reinforcement theory ([Skinner, 1968](#)) are examples of theories consistent with the behavioral approach. Scholars using this approach can point to numerous studies that have found that rewards are associated with greater creativity (e.g., [Eisenberger and Rhoades, 2001](#)).

Whereas the behavioral approach suggests that rewards increase creativity, the cognitive approach is often used to suggest that rewards decrease creativity. According to the cognitive approach, intrinsic—rather than extrinsic—motivation is essential to task performance such as creative performance. Extrinsic motivation—such as from the promise or receipt of rewards—undermines intrinsic motivation by suggesting that people no longer have control over what they think and do. They are being driven to act based on what is being rewarded, not what innately drives or interests them. By reducing intrinsic motivation, rewards decrease task performance such as on creative tasks or projects. Cognitive evaluation theory (CET) ([Deci et al., 1975](#); [Deci and Ryan, 1980](#)) and self-determination theory (SDT) ([Deci and Ryan, 1985](#)) are examples of theories consistent with the cognitive approach. Scholars using this approach can point to numerous studies that have found that rewards are associated with decreased creativity (e.g., [Amabile, 1982](#)).

Historically, scholars tended to side with one of these two opposing theoretical approaches. More recently, scholars have been able to rely on contemporary theoretical approaches that consider that rewards can help, harm, or have no effect on creativity—and that aspects of the reward and context determine reward's effect on creativity.

These contemporary perspectives consider rewards as not standing in opposition to intrinsic motivation. [Amabile \(1993\)](#) introduced the notion of “extrinsics in service of intrinsic” (p. 194). She argued that rewards and other forms of extrinsic

motivation can increase intrinsic motivation because people enjoy receiving recognition, praise, and other desired outcomes and such enjoyment can increase the pleasantness of work. In this way, rewards may increase creativity, which is considered highly dependent on intrinsic motivation. Extending this view, [Amabile and Pratt \(2016\)](#) presented a model examining the antecedents of creativity and asserted that extrinsic motivators can synergistically work with intrinsic motivation to increase creativity.

Finding theories to be inadequate at explaining previous research, [Byron and Khazanchi \(2012\)](#) theorized that five mechanisms account for the extent to which rewards either increase or decrease creative performance.

In short, when rewards or their context serve to clarify that creative (rather than routine) output is desired and valued, increase one's perceived competence on the task, associate positive emotion with the task, decrease the association of negative emotion with the task, or increase one's perception of being volitional, rewards are more likely to increase creative performance. In contrast, when rewards or their context fail to clarify creativity as a criterion, decrease one's perceived competence on the task, decrease the association of positive emotion with the task, associate negative emotion with the task, or impose control, rewards are likely to decrease creative performance

([Byron and Khazanchi, 2012](#), p. 811).

Their meta-analytic results—which are summarized below—largely supported these theoretical contentions.

In a refinement of cognitive evaluation theory, [Gagné and Deci \(2005\)](#) similarly argued that rewards—in the right context—can increase intrinsic motivation and thus potentially increase creativity. They proposed that rewards, when administered in an autonomy-supportive climate, can enhance intrinsic motivation. For example, [Ryan et al. \(1983\)](#) provided supporting evidence that research participants offered performance-contingent monetary rewards in an autonomy-supportive context had greater intrinsic motivation than did those participants who were not offered rewards.

In summary, rather than considering rewards as being antithetical to intrinsic motivation and thus creativity, contemporary perspectives offer a more nuanced approach to considering how rewards influence creativity. Such a perspective is in line with the vast majority of empirical evidence, as demonstrated by meta-analytic results ([Byron and Khazanchi, 2012](#)). The next section summarizes this meta-analysis, which sought to answer the question “Do rewards help or hinder creativity?”

Meta-Analytic Review of the Reward–Creativity Link

As mentioned earlier, evidence on the reward–creativity relationship has been mixed: some studies found that rewards increased creative performance and others found that rewards decreased creativity performance. Because of the conflicting results and theoretical perspectives, [Byron and Khazanchi \(2012\)](#) conducted a meta-analysis of existing research that examined the relationship between rewards and creativity. This quantitative synthesis included 60 studies (including 69 independent samples) conducted on a variety of populations (e.g., of varying ages), in a variety of contexts (e.g., work organizations, schools), and using different research designs (i.e., both experimental and nonexperimental designs). Its goal was to explain and resolve the inconsistencies found in prior research. Key findings included considering how reward contingency, reward conditions, and accompanying performance feedback help explain how rewards effect creativity.

First, reward contingency matters. Rewards increase creativity when individuals understand that rewards are contingent on creative performance. The analysis of experimental studies found that creativity-contingent rewards increase creativity and results from the nonexperimental studies concluded there is a small but positive and stable relationship between perceived rewards for creativity and creative performance. In contrast, performance-contingent and completion-contingent rewards did not increase creativity:

When individuals are unclear about the performance criterion or need only participate or complete a task to receive a reward, rewards had almost no effect (i.e., a slightly negative effect that was not significantly different from zero) on creative performance

([Byron and Khazanchi, 2012](#), p. 823).

Second, reward conditions matter. More specifically, creativity-contingent and performance-contingent rewards are more positively related to creativity when participants are given more choice and are less controlled. Rewards offered in conditions that also provide choice—being able to choose the reward or task, for example—benefited creative performance. In contrast, rewards offered in conditions that impose control—offering contracted-for rewards or imposing excessive time constraints, for example—harmed creative performance. It may be that rewards offered along with choice increase task engagement and thus cognitive flexibility whereas rewards offered along with control decreases task engagement and thus cognitive flexibility.

Third, accompanying performance feedback matters. Rewards tended to be more positively related to creativity when individuals were provided with performance feedback that was more positive, specific, task-focused, and contingent on their creative performance. Performance feedback may augment the positive effects of rewards on creativity by, for example, increasing perceived competence and creating positive affective states. People who feel more competent and positive may be more likely to think in a way that promotes creativity—such as having a broad attentional focus and being cognitively flexible.

These results also highlight that the relationship between rewards and creativity is more complex than previously thought. Although the meta-analysis identified important moderators of the rewards–creativity relationship, research since then has further refined what is known about this relationship—and is the subject of the next section.

Additional Research Examining the Reward–Creativity Link

Scholars continue to study the effects of rewards on creativity—to identify boundary conditions, explore intervening mechanisms, and extend effects to different domains (e.g., [Malik et al., 2015](#); [Ng and Yam, 2019](#); [Yoon et al., 2015](#)). This section will review recent theorizing and empirical tests from research scholars published since the [Byron and Khazanchi \(2012\)](#) meta-analysis.

Byron and Khazanchi called on researchers to examine boundary conditions that might affect creative performance. Specifically, they suggested that researchers examine the effects of individual differences in value perceptions of rewards:

... people likely differ in how they perceive and value different types of rewards, and these differences may help determine the effects of rewards. More specifically, whereas some people view monetary rewards as controlling, others view money as a source of freedom ...

Byron and Khazanchi (2012, p. 825).

Some research looked at mediating variables of the rewards–creativity relationship. For example, [Malik et al. \(2015\)](#) and [Yoon et al. \(2015\)](#) both examined the effect of external rewards on creative performance and found positive relationships through other variables. [Malik et al. \(2015\)](#) looked at the effect of external rewards on creative performance through intrinsic motivation and found that this indirect relationship was positive when employees perceived an internal locus of control instead of an external locus of control. [Yoon et al. \(2015\)](#) found a positive relationship between external rewards and creative performance with commitment to creativity as an intervening variable.

Additionally, these authors examined the effects of moderators on the external rewards–creative performance relationship. For example, [Malik et al. \(2015\)](#) found that creative self-efficacy—belief in your own creative skills and abilities—moderated the extrinsic reward–creativity link, such that rewards were more positively related to creativity when people had high (rather than low) creative self-efficacy. When people have high creative self-efficacy, they are driven by their internal belief in their creative abilities and external rewards combine with these beliefs to enhance creativity. In contrast, when people feel that they lack the skills to perform creatively, they likely do not believe that receiving the promised external reward is even possible—and thus rewards fail to motivate creativity.

Another important moderator appears to be the perceived importance of the reward. [Malik et al. \(2015\)](#) and [Yoon et al. \(2015\)](#) found that, for employees who considered the rewards high in importance, rewards were positively related to creativity; for employees who considered the rewards low in importance, rewards were negatively related to creative performance.

Moreover, task complexity moderates the relationship between rewards and creativity. [Hewett and Conway \(2016\)](#) examined the effects of the complexity of tasks on the verbal reward salience–creativity relationship and found that the more complex the task, the less effective the verbal reward in increasing intrinsic motivation (and seemingly creativity). The relationship between reward salience and intrinsic motivation was increased when the verbal reward was given for simpler tasks.

In summary, these findings support assertions that extrinsic motivators positively influence creative performance directly and indirectly especially when the appropriate synergistic conditions are in place. Such findings have important practical implications. For example, when an employee displays low confidence in his or her ability to be creative, a manager may downplay the extrinsic rewards of creativity so as not to lessen the creative output.

Conclusion

Scholars are encouraged to continue exploring the nuances of the reward–creativity relationship. One area for future research concerns the effects of time on the relationships between rewards and creativity. For example, scholars might examine the effects of rewards on creativity over time to determine how the frequency of rewards affects creativity in the long-term. Longitudinal studies may examine whether some reward types are more effective early in a career or learning environment when people are developing creative skills versus when they are more “seasoned.” Many opportunities exist to further understanding of the reward–creativity link.

What would be the impact if creativity went unrewarded? Most simply, without rewards for their creative performance, many artists, musicians, and inventors would struggle to survive—especially early in their careers. Moreover, if creative performance is not rewarded sufficiently in the workplace, employees may withhold their creative behavior because of this seemingly unfair treatment. Research shows that organizational justice impacts employee attitudes (i.e., job satisfaction, organizational trust, organizational commitment), counter-productive work behaviors, organization citizenship behaviors, and overall task performance ([Colquitt et al., 2013](#)). In essence, not rewarding creative performance violates norms of society, particularly in Western cultures.

Whereas early theory and research was focused on *whether* rewards increase or decrease creativity, more recent theory and research is focused on *how and when* rewards increase or decrease creativity. Moving away from earlier simplistic views of rewards,

it is clear that the relationship between and creativity is complex relationship. Hopefully future research will help further unravel rewards' effects on creativity.

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Schizotypy

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Introduction

When you are insane you are busy being insane – all the time ... When I was crazy that was *all* I was
 Sylvia Plath, cited in *Sounds from the Bell Jar*, Claridge, Pryor and Watkins, 1998, p. 4.

This entry introduces the construct of schizotypy and examines whether schizotypy confers a creative advantage, and if so, why. While schizophrenia has been associated with impaired functioning and with low levels of creativity, high levels of creativity have been observed amongst people who score highly on subclinical measures of schizotypy, and amongst non-diagnosed relatives of people who have been diagnosed with schizophrenia (Sass and Schulberg, 2000–2001). This led to suggestions that cognitive mechanisms underpinning aspects of schizophrenia may also facilitate creativity, but only when expressed at mild to moderate levels and/or in interaction with ‘protective factors’ that enable healthy functioning. However, both schizophrenia and schizotypy are multi-dimensional and complex constructs, as is creativity, and it will be argued that not all aspects of schizotypy are useful for creativity, and that not all types or subcomponents of creativity are potentially related to it. Further, since creativity has also been associated with healthy, efficient and adaptive functioning, the apparent paradox that it may also be associated with schizotypy will be explored.

The definition of creativity will follow the most commonly accepted version, as: a process through which a novel and useful or adaptive product or performance ensues. Creativity is considered to be multi-dimensional and to consist of numerous potential processes (neurocognitive, affective, behavioural), numerous potential domains (e.g., everyday life, the arts, sciences, intrapersonal) and multiple stages, including processes that are generative or explorative and enable novelty and processes that enable the selection, evaluation and development of material that renders a product or performance adaptive.

What Is Schizotypy?

The term schizotypy is used to describe a heterogeneous mix of experiences, expressed at a subclinical level, that are analogous to those that categorise schizophrenia (Mason and Claridge, 2015). These include experiences analogous with the positive, negative and disorganised symptoms of schizophrenia.

The positive symptoms of schizophrenia consist of hallucinations and delusions, but in schizotypy are expressed in forms more commonly experienced in everyday life, such as: 'magical thinking', including a belief that telepathy (mind-to-mind communication without the use of the five senses) is possible; pseudo-hallucinations, such as having had a 'sense of presence' (perhaps evil and foreboding) despite no person being physically present; perceptual aberrations, such as seeing shapes and colours in the dark when nothing is there; and cognitive aberrations, for example, one's thoughts seeming to be so vivid that one can almost hear them (analogous with the most common form of hallucination in diagnoses of schizophrenia – hearing voices).

The negative symptoms of schizophrenia are characterised by an absence of pleasure and engagement with aspects of everyday life (avolition, anhedonia, alogia). In schizotypy, such experiences include physical anhedonia, gaining little or no pleasure from the senses or from experiences that are usually deemed to be pleasurable (such as enjoying the taste of new foods or dancing), and social anhedonia, preferring solitary activities to spending time with others and not feeling close to other people.

In schizophrenia, cognitive disorganisation refers to problems with executive function, such as sustained attention, and is characterised by cognitive derailment and 'word salad' (where speech appears to be tangential with an unusual logical structure and choice of words). In schizotypy, cognitive disorganisation is expressed in a milder form, for example, as being easily distracted by daydreams, or feeling overwhelmed when walking into a crowded, busy room.

Some measures of schizotypy also include a fourth, and more contested dimension, called impulsive non-conformity. This construct is thought to overlap with psychoticism and includes thoughts and behaviours that are impulsive or antisocial, such as feeling an impulse to do something harmful or shocking or wishing other people to be afraid of oneself. This construct also overlaps with mood lability and hypomania.

Clearly then, schizotypy is a multi-dimensional construct, and it is important to note that these four dimensions do not share the same associations with cognitive and wellbeing measures. For example, the positive dimension correlates less consistently with indices of poor executive functioning and wellbeing, and in some research is associated with high levels of wellbeing, unlike the negative and disorganised symptoms.

While schizotypy is typically modelled as a personality trait, where people vary on a continuum according to how 'schizotypal' they are, there is debate concerning its health implications (Mohr and Claridge, 2015). This debate revolves around evaluating and interpreting the empirical support for two competing models of schizotypy – the 'fully dimensional' and 'quasi dimensional' models. Essentially, these models differ in the extent to which schizotypy is thought to be on a continuum with schizophrenia. The fully dimensional model considers schizotypy to be neutral in terms of its health implications, and to be a personality trait, albeit one where high levels may predispose people to psychosis in the presence of risk factors (e.g. stressful life events, a lack of social support and appraising schizotypal experiences as being distressing).

Importantly, in the fully dimensional model, trait level expressions of schizotypy in a healthy population are on a continuum with symptoms on the schizophrenic spectrum, with no clear dividing line between 'normal' and 'abnormal' experiences. It is important to note that this model allows for the possibility that schizotypal experiences may be adaptive, for example heightening creativity or a sense of living a meaningful life (eudaimonic happiness), and as such supports the construct of 'healthy schizotypy'. Alternatively, the quasi dimensional model considers schizotypy to be a 'forme fruste', a risk factor for psychosis, that is indicative of dysfunction (wellbeing, social, cognitive), albeit sometimes expressed in mild and manageable forms in daily life.

The quasi dimensional model is categorical, where, rather than everyone being on a schizotypal dimension, some people are schizotypal and others are not, and the estimated 10% of the general population who are schizotypal are thought to be at risk for developing psychosis. It is for this 10% of individuals where a 'dimension' lies in the model, where there are variations in the severity of the schizotypal experiences.

Schizotypy, then, is not only a heterogeneous construct, but can be understood in different ways, as a risk factor for psychosis, or as a personality trait with potentially adaptive outcomes. These models impact the interpretation of any relationship between creativity and schizotypy. For example, at a simplistic level, a relationship could either be interpreted as supporting a link between creativity and 'mental illness' or as illustrating adaptive and normative expressions of schizotypy. Further, research examining the relationships between creative functioning, schizotypy and wellbeing can potentially provide support for either of these models, and this issue will be returned to later in this entry.

Just as there are diverse operational definitions and measures of creativity, there are a range of schizotypy questionnaires in the literature and the differential use of these may obfuscate relationships. For example, different schizotypy questionnaires vary in the severity of items, some including more 'symptom-like' experiences, with implications for their correlations with both wellbeing and creativity measures. Questionnaires that assess positive schizotypy with 'milder' experiences include items such as 'sometimes seeing shapes and forms in the dark' and having 'rushes of insights', rather than items such as 'feeling like my body is rotting inside' and being 'hyperaware of and unable to shut out sounds and sights', items that are both more negative and involve lack of control.

Schizotypy questionnaires are also sensitive to response biases. For example, participants are more likely to report having had schizotypal experiences if the questionnaire is presented as being relevant to creativity, compared to being presented as a clinical measure. As such, it can be difficult to compare schizotypal findings and levels across studies. Finally, issues arise in the literature due to unmeasured interacting variables and curvilinear patterns, where, for example, moderate levels of schizotypy might enhance creativity, while high levels may inhibit it, or aspects of it. The caveats discussed in this paragraph, in addition to the multidimensional nature of both creativity and schizotypy, must be borne in mind when examining the empirical support for a link between schizotypy and creativity.

Might Schizotypy Confer a Creative Advantage?

Literature reviews and meta-analyses do support a link between creativity and schizotypy. However, the relationship appears to hold for certain dimensions of schizotypy and types of creativity only. For example, in the first meta-analysis of this field, including 45 studies, [Acar and Sen \(2013\)](#) reported a significant but small positive relationship between the positive-impulsive dimensions of schizotypy (which they combined) and creativity measures (which included a broad range, such as divergent thinking, creative personality and artistic involvement). However, negative and disorganised symptoms (combined) appeared to inhibit creativity. Further, literature reviews have reported that the most robust and consistent relationship is between positive schizotypy and artistic involvement (and to a lesser extent with the making of remote cognitive associations) ([Mason and Claridge, 2015](#)). As such, the relationship between creativity and schizotypy may be specific, where particular dimensions of schizotypy relate only to certain types of creativity (or to certain stages of the creative process). This specificity will be considered below, examining the relationships between each dimension of schizotypy and creativity.

Positive Schizotypy

The positive dimension of schizotypy, and unusual experiences more generally, has been most frequently studied in relation to creativity. This may be due to descriptions of unusual experiences in the creative process by famous artists and scientists, many of which are well-known, and have been linked with ‘moments of inspiration’, experiences of ‘the muse’, or intense absorption in the creative process. Examples include the hypnagogic pseudo-hallucination in which the 19th Century theoretical chemist August Kekulé reported seeing patterns ‘gambolling before his eyes’ in which an ouroboros could be discerned, suggesting to him that the structure of benzene, for which he was searching, was circular. Other examples include the reverie of Samuel Taylor Coleridge in which he reported ‘images rising up’, producing without conscious effort the poem *Kubla Kahn*, and the hallucinatory experience of Edvard Munch, whom, whilst walking with friends by a ‘blue black fjord’ reported that a “great scream pierced through nature”, expressed in his most famous painting ([Holt, 2012](#)).

Less often discussed are the experiences of sensed presence and dissociation that have often been reported by creative writers, as illustrated by William Thackeray, who wrote: “I have been surprised at the observations made by some of my characters. It seems as if an occult power was moving the pen. The personage does or says something, and I ask, how the dickens did he come to think of that?” ([Holt, 2012](#)) (See Writing).

A more common form of dissociation reported in the creative process, accompanies intense involvement and attentional focus, often with a loss of awareness of self, boundaries, time and place. This state is akin to the flow state and is described clearly by Marion Milner in her book *On Not Being Able to Paint* (1950, p. 152) when absorbed in painting: “The process always seems to be accompanied by a feeling that the ordinary sense of self had temporarily disappeared, there had been a kind of blanking out of ordinary consciousness; even the awareness of blanking out had gone, so that it was only afterwards when I had returned to ordinary consciousness that I remembered that there had been this phase of complete lack of self-consciousness”.

Clearly then, states characterised by pseudo-hallucinations and dissociation, core features of positive schizotypy, have been implicated in the creative process in numerous ways, both inspiring and accompanying creative production. Nevertheless, such anecdotal reports might be distorted by reporting biases, for example, being misremembered or exaggerated, perhaps to reinforce an image of ‘creative genius’ ([Sass and Shuldberg, 2000–2001](#)).

A number of empirical studies have compared levels of schizotypy amongst artists, scientists and ‘non-artist’ groups (or with normative schizotypy scores) ([Holt, 2018](#)). Positive schizotypy has consistently been found to be significantly higher amongst artists (including poets, visual artists and musicians) compared with control and scientist groups. For example, [Rawlings and Locarnini \(2008\)](#) compared the schizotypy levels of professional artists with scientists. Artists scored significantly higher than scientists on positive schizotypy. The authors further reported that this relationship appeared to be mediated by the ability to make more original and idiosyncratic responses on a word association test. Indeed, much of the research on positive schizotypy and creativity has been based on associative models, where it is hypothesised that they share cognitive features (such as ‘over-inclusive thinking’) that enable remote associations to enter awareness, a process that might both facilitate novel combinations (required for creativity) and irrelevant associations that may be apophenic (the apprehension of aberrant meaning) and lead to delusional ideation in the context of schizotypy. The findings of [Rawlings and Locarnini \(2008\)](#) supported previous studies finding a link between positive schizotypy and idiosyncratic associations, collectively providing some support for this hypothesis.

However, the relationships between positive schizotypy and other measures of creativity, such as creative personality and divergent thinking are less clear, with conflicting outcomes. This may reflect the characteristics or limitations of the measures involved, as well as the inconsistent use of measures across studies, or, as indicated by [Acar and Sen’s \(2013\)](#) meta-analysis, any effect may be a small and unlikely to be consistently detected in studies with small sample sizes. Different creativity measures operationally define creativity in different ways, ways that may differentially relate to schizotypy. For example, the most commonly used measure of creative personality may be confounded with traits required to be a ‘successful’, professional ‘creative’ since it was validated with high achieving samples (and includes items such as self-confident, egotistical, dominant). As such, this scale may not effectively measure the thoughts, feelings and behaviours associated with ‘everyday’ creativity. Divergent thinking tasks require one to select and develop one’s most original ideas rather than simply ‘free associating’ and responding immediately. As such they may require

more sustained attention and evaluative cognition than word association tasks. Currently, the clearest research outcomes are that positive schizotypy is associated with particular domains of creativity (the arts) and may facilitate the generation of 'novelty' in the creative process (at least in terms of making original word associations).

Impulsive Nonconformity

At a behavioural level, taking risks and breaking norms has clear overlaps with creative personality traits. Indeed, impulsive and 'antisocial' traits were observed in the development of early creative personality scales, where it was noted that successful 'creatives' often described themselves as hostile, impulsive, norm-doubting and as not being commonplace. Like positive schizotypy (but less consistently), impulsive non-conformity has been found to be higher amongst artists than the general population (Holt, 2018). It has been argued that this may be due to a willingness to question common values and perceptions, to deviate from norms and conventions, and to express potentially shocking ideas; behaviors that find useful expression through the arts. Interestingly, research suggests that impulsive nonconformity may facilitate the making of remote associations by disinhibiting taboo, antisocial or idiosyncratic associations. Such disinhibition would widen the availability of original associations. Responses on word association tests have been found to be particularly original when participants have scored highly on both positive and impulsive schizotypy traits, and schizotypy has predicted making word associations that are both more original and socially 'taboo'. This suggests that schizotypy might be associated with originality partly through a willingness to explore 'socially undesirable' responses.

Cognitive Disorganisation

Cognitive disorganisation forms mixed, often null, outcomes with measures of creativity and appears not to be useful for creative functioning, and, as suggested by the small negative effect in Acar and Sen's (2013) meta-analysis, may even impair it. Since it has been related to distractibility, social anxiety, low self-efficacy, emotional confusion and reduced conscientiousness, perhaps this is not surprising, since it may limit creative achievement through reduced determination, focus and confidence, traits that identify individuals on measures of creative personality. Cognitive disorganisation has clearer links with cognitive 'dysfunction' than positive and impulsive schizotypy, being associated with poor executive control and reduced semantic fluency, suggesting that it is antithetical to creativity at both a trait and cognitive level. However, some (inconsistent) studies have observed higher levels of cognitive disorganization amongst artists, for example musicians (Rawlings and Locarnini, 2008). This may be due to response biases, type one errors, some unidentified factor of cognitive disorganisation that promotes creativity, or perhaps to stressors associated with working as a professional artist.

Negative Schizotypy

With its emphasis on social anhedonia, it has been suggested that negative symptoms could make solitary work easier to bear, withdrawing to focus on creative endeavours. However, most research finds that negative symptoms inhibit or play no role in creativity, supporting Acar and Sen's (2013) meta-analysis. For example, negative schizotypy is not inflated amongst artistic samples. Further, in a sample of artists it inversely predicted experiences in everyday life that often co-occur with creativity, including the flow state and positive affect. Rather, it was associated with moments of low self-esteem, tension and apathy (Holt, 2018). In other research negative symptoms have been associated with lower levels of openness-to-experience, reduced verbal fluency and executive dysfunction, all of which are important to creativity. Potentially, then, negative schizotypy may inhibit creativity in numerous ways, due to a lack of: excitement and sensation seeking (not exploring ideas and experiences); social support (withdrawing from others, who might help or inspire them); and less frequent positive moods in everyday life, which facilitate original ideation.

Summary

Only certain dimensions of schizotypy (the positive dimensions) appear to be linked with creativity – and further, this is limited to particular domains and stages of the creative process: the discovery of new and original ideas; and absorption in the creative process. This does not support a strong and direct link between the schizophrenic spectrum and creativity, but rather suggests that any link is partial and specific, and related to dimensions of schizotypy that are least associated with cognitive and social impairment and low levels of wellbeing. It is of interest that artistic samples have displayed schizotypal profiles characterised by positive but not negative dimensions of schizotypy. However, it is not clear how positive schizotypy might be useful to creativity, whether, for example, schizotypy might lead to creative insights or to autotelic states, such as the flow state that motivate engagement with the creative process. It is to such considerations that this entry now turns.

Why Might Creativity and Schizotypy Be Related?

Different approaches have been taken in attempts to understand why creativity and schizotypy might be related, including cognitive, trait, state, and affective and motivational approaches. These models not only have implications for understanding the potential mechanisms at play, but also whether links are direct or indirect, and the direction of any causal explanation. While it is commonly

assumed that there is something about schizotypy that leads to creativity, for example through 'loose cognitive associations' that facilitate novelty, not all explanations follow this causal trajectory. For example, some motivational models suggest that schizotypal individuals might engage with the arts as a way to express and explore their unusual experiences. Further, it has been argued that schizotypy and creativity might be indirectly related through some shared third variable, such as openness to experience. Such issues will be briefly explored in the following sections. Most of this work has focused on the positive dimension of schizotypy, and therefore this review will do likewise, although it is of note that some models argue that negative schizotypy works in the opposite direction, supporting a bi-directional model of their relative impact on creativity.

Cognitive Explanations

Aspects of cognition which are thought to lead to cognitive impairment in the context of schizophrenia have also been linked to both schizotypy and creativity. These include reduced top down control, cognitive disinhibition and widened attentional capacity. Much theoretical and empirical work has focused on cognitive disinhibition and the idea that there may be a continuum of 'cognitive looseness', ranging from functional fixity to fluid associative cognition (with increased access to remote associations) to increasingly psychopathological and disorganised ideation (being bombarded by irrelevant cognitive content). Such models draw upon early associative models of creativity, where creativity was defined as the making of relevant but remote associations. Hans Eysenck suggested that latent disinhibition might be the mechanism that enables remote associations.

Latent inhibition refers to the effective filtering of irrelevant information from attention, an unconscious process that reduces the load on working memory, and is required for effective functioning in everyday life. Tests of latent inhibition expose participants to an irrelevant stimulus and inhibition of this stimulus is thought to occur when it is subsequently ignored (filtered out of attention due to its 'irrelevant' status). Latent disinhibition, where the stimulus is not subsequently ignored, has been found amongst those scoring highly on both the positive and impulsive dimensions of schizotypy, whereas latent inhibition has been associated with negative schizotypy, although there are discrepancies in the literature.

Several studies have explored whether latent disinhibition is associated with creativity. Carson et al. (2003), for example, reported that psychology undergraduates with high levels of creative achievement were more likely to attend to the irrelevant stimulus in the testing phase, demonstrating latent disinhibition. This effect has been replicated with professional actors, but again, measures of divergent thinking and creative personality have had mixed success as predictors. The relationship may be complex and depend upon factors such as level of schizotypy, intelligence, gender, and cognitive load of the masking task. However, latent inhibition tasks might not be best suited to assessing the potential tendency of creative individuals to access states characterised by cognitive disinhibition, since research suggests that creative people may be able to shift between defocused and focused attentional states according to task demands – being 'ambicognitive' – able to focus on intelligence tasks and 'daydream' on creativity tasks. Hence, masking tasks that are playful and encourage disinhibition (rather than encouraging focused attention) might achieve stronger results.

Overall, while cognitive explanations are theoretically compelling, the link between them and both schizotypy and creativity has limited support and requires more careful research to determine the conditions under which any relationship might be reliably replicated. Research on shared neurological correlates might also deepen understanding, for example, both schizotypy and creative idea generation may share reduced deactivation of the right prefrontal cortex, which is involved in numerous complex states such as episodic memory retrieval, mental imagery and self-consciousness (Fink et al., 2014). Deactivation of the prefrontal cortex has been correlated with focused attention (suppressing unnecessary stimuli), and reduced deactivation with altered states, such as sleep and mystical experiences. As such, this suggests that both schizotypy and idea generation may both be underpinned by mechanisms that enable defocused attention and more stimuli entering attention. Further research on additional cognitive features and mechanisms that might link creativity and schizotypy would be useful, for example, vivid internal imagery, since daydreaming, characterised by focusing on internal stimuli (typified by visual imagery, memories, fantasies of possible events and internal monologues) has been found to be predictive of both schizotypy and creativity.

Motivational and Affective Explanations

Affect and motivation might better explain the relationship between positive schizotypy and creativity. Positive schizotypy has been found to significantly and positively correlate with cyclothymia and hypomania, leading to propositions that heightened experiences of positive affect and motivation amongst people who score highly on positive schizotypy might drive the creative process. This is supported by research suggesting that motivation and moderate positive moods (especially positive and 'approach' emotions, such as joy) facilitate creativity; findings which have been explained by dopaminergic models, which are also implicated in schizotypy. Baas et al. (2019) linked positive schizotypy (and hypomania) with 'approach emotions' (and negative schizotypy with the avoidance system) and found that this cluster (positive schizotypy and hypomania) significantly predicted divergent thinking.

Further research has tracked the moods, and time spent making art, of artists using the experience sampling method (Holt, 2018). After making art artists reported feeling happier and had higher levels of self-esteem. Artists who scored highly on positive schizotypy also reported making art more often and had a significantly greater increase in positive affect after making art than those who scored lower on positive schizotypy. This aligns with Baas et al.'s 'approach-avoidance motivation' model and suggests that positive schizotypy might increase sensitivity to reward and being motivated to seek it out (the reward of feeling good after art

making in this case). Baas et al. also suggested that the approach system motivates people to seek out novelty, which may increase ideas and experiences available to make remote associations. There are clearly conceptual overlaps with the cognitive models discussed above, since positive affect also increases the making of remote associations, and further theoretical work to link neurocognitive and affective/neurochemical approaches would be useful.

Overall, evidence supports variability in affect and motivation as an explanatory variable in the relationship between positive schizotypy and creativity, however, the causal nature of this requires further elucidation. While it is possible that sensitivity to reward drives the creative process, and that positive affect increases novel associations, additional interpretations could be made. For example, high levels of motivation to create could lead to sleep deprivation, which is linked with unusual experiences. Alternatively, having unusual experiences itself may motivate people to express these through the arts, since they enable subjective, idiosyncratic exploration and representation, which may lead to increased wellbeing through catharsis. Finally, there may be a shared third variable that leads to creativity/artistic involvement, positive schizotypy and moments of rewarding positive affect, such as openness-to-experience.

Personality Explanations

Openness-to-experience has been proposed as a potential third variable that might predict behaviour, affect and cognition associated with aspects of both schizotypy and creativity. As a trait, openness-to-experience involves an openness to and exploration of novel and unconventional ideas, sensation seeking and curiosity about both 'inner and outer worlds'.

Openness-to-experience is a strong predictor of creativity and has also been found to correlate with positive schizotypy (and negatively with negative schizotypy). In an interesting study, Miller and Tal (2007) reported that openness-to-experience explained the variance between creativity and schizotypy and argued that personality models were more useful than models of psychopathology to explain their association. Curiosity may lead to the exploration of unusual perspectives and ideas and openness to these (e.g. paranormal beliefs), as well as asking questions and considering novel approaches which may facilitate creativity. Seeking out new experiences may also be linked with both creativity and schizotypy, for example meditation or drug-induced experiences. That the taking of psychotropic drugs has been reported to be higher amongst professional artists and those who score highly on positive schizotypy, supports the hypothesis that positive schizotypy amongst artists may be a by-product of experience-seeking (See Drugs and Personality: Openness).

State Explanations

Both positive schizotypy and creativity can involve dissociative states (the temporary alteration or separation of mental processes that are normally experienced as integrated). Indeed, positive schizotypy might facilitate normative dissociative states such as daydreams and the flow state that might foster engagement in the creative process. Mihaly Csikszentmihalyi observed that the flow state was a common component of the creative process, described by eminent artists and scientists whom he interviewed. This state involved a loss of self-awareness in moments of intense concentration.

Nelson and Rawlings (2010) found that amongst a sample of artists, positive schizotypy predicted reporting moments of normative dissociation in the creative process, including creative experience being 'distinct' from everyday experience (e.g. a loss of self-awareness) and entering states of deep absorption. They suggested that positive schizotypy may facilitate the 'flow state' but did not directly test this. Nevertheless, this has been supported by further research where positive schizotypy predicted experiencing the flow state in daily life in a sample of artists (Holt, 2018). Interestingly, in this study negative schizotypy was negatively associated with the flow state, and also with avolition and negative affect, supporting the idea that positive and negative dimensions of schizotypy operate in opposing directions in relation to creative functioning (in the arts at least) (See Flow).

In summary, despite limited research exploring this topic, there is evidence to support the idea that positive schizotypy may be expressed in a particular way in creative samples, being associated with adaptive absorbed attentional states. Yet, in undergraduate and clinical samples, positive schizotypy has been associated with 'unhealthy' forms of dissociation (e.g. depersonalisation and derealisation). Further research could explore types of dissociation that might mediate a link between positive schizotypy and creativity, and even their developmental pathways, since different pathways to dissociative experiences have been proposed, through experiences of childhood trauma (depersonalisation and derealisation) versus encouragement to engage in creative and imaginative play (absorption).

Summary

There may be multiple pathways between creativity and positive schizotypy, where it can facilitate novel ideation, drive the creative process through sensitivity to approach emotions, or increased access to autotelic states such as the flow state. Although evidence for these links needs to be improved, and causality better understood, aspects of the above models could potentially be synthesised into a broader systems model that accommodates cognitive, affective, motivation, trait and state factors. Indeed, the different mechanisms reviewed may be forms of 'openness' or 'approach systems' at different levels: behavioural (sensation seeking); affective and motivational (positive affect and flow); and cognitive (loose playful associations).

Social factors need also to be considered. For example, research takes place as a social activity, and may be limited by demand characteristics, including response biases, where, for example, it may be more acceptable amongst artistic populations to endorse

statements that are unusual or taboo, which may explain inflated schizotypy scores. Social perspectives are also a reminder that it is convention and gatekeeping that decides both what is 'schizotypal' and what is 'creative' (Sass and Shuldborg, 2000–2001). It is possible that understanding of some of the issues at hand would benefit from expanding social constructions of what is 'normal' everyday experience versus 'schizotypal' experience.

Dual Factor Models

Even at its most simple level the creative process is commonly modelled as being comprised of multiple states, states that require expansion versus constriction, both the broadening of cognitive associations to generate new ideas and the inhibition and focus required to select the most appropriate ideas and develop them into a creative product or performance. In order to engage with both of these stages creative individuals may need more than inflated positive and impulsive schizotypy scores. Creativity is not just associated with aspects of schizotypy, but with indices of wellbeing and executive functioning, such as happiness, intelligence and working memory. Noting this complexity, dual-factor models propose that creativity is associated with both traits indicative of a predisposition to psychopathology (such as schizotypy) and 'protective' factors (e.g., resilience, intelligence, executive functioning, cognitive flexibility).

This is not a new idea. In the 1960s Frank Barron observed that highly creative individuals scored highly on indices of both psychopathology and wellbeing (e.g. ego strength), leading him to coin the term 'controllable oddness' to describe the harnessing of novel and idiosyncratic perspectives to an applied and adaptive end. A more recent approach, suggested early on by Ruth Richards, and later by Shelly Carson, proposed a 'shared vulnerabilities model' where, for example, vulnerability to cognitive disinhibition interacts with protective factors such as intelligence and working memory capacity to enable creativity (See Compensatory Advantage).

Indeed, some research supports this, where high creativity scores have been found amongst participants who score highly on both psychosis-proneness and resilience; latent disinhibition and intelligence; idiosyncratic word associations plus efficient executive functioning (the ability to inhibit responses when required); overinclusive thinking and cognitive inhibition; and schizotypy and both divergent and convergent cognition. Cognitive flexibility may enable high creatives to shift along 'associative hierarchies' according to task demands, being both 'schizotypal' and 'non-schizotypal' as required.

In addition to the presence of protective factors, however, the absence of risk factors may be equally important. As discussed earlier, the relationship between creativity and schizotypy is complex, since positive schizotypy may increase and negative schizotypy decrease the expansion and the generation of ideas, for example. As such the absence of negative and disorganised schizotypy might be required for creative functioning. Research has identified different schizotypal profiles: healthy schizotypes (who only score highly on positive dimensions); high schizotypes (who score highly on positive, negative and disorganised symptoms); low schizotypes (who have low scores on all dimensions); and negative schizotypes (who score highly only on negative schizotypy). Of the two profiles characterised by positive schizotypy it is the so-called healthy schizotypes alone who have scored highly on levels of wellbeing. The research described in this chapter has often conflated these two profiles, and future work could profitably examine creativity amongst 'healthy schizotypes'.

In summary, research and theory supports Barron's notion of 'controllable oddness'. However, how exactly this works, and which protective factors are required, is not clear. For example, this may purely be a function of curvilinear patterns, where moderate levels of positive schizotypy facilitate novel ideation without impairing cognitive function. Alternatively, high levels of positive schizotypy might still lead to creativity, as long as protective factors are present, factors which are orthogonal to schizotypy but interact with its expression. More understanding of how positive schizotypy is phenomenologically expressed in creativity would be useful to understand these issues, since unusual experiences may be of a different type than those associated with psychopathology (e.g. normative dissociation and 'rushes of ideas' rather than paranoid ideation and apophenia).

Conclusion

There appear to be multiple links between creativity and schizotypy that deserve further exploration, both empirical and theoretical: neurocognitive, affective, state and trait. Positive schizotypy may facilitate both: novel ideation that may inspire the creative process; and states of positive affect and flow that may drive the process. Further research is required to articulate the precise mechanisms by which this may occur and validate such causal hypotheses. However, the research on creativity and schizotypy is enmeshed with problems with the operational definitions of both constructs. For example, much of the research links positive schizotypy with artistic involvement and the making of remote associations. However, involvement with the arts does not require creativity in that domain, and idiosyncratic thoughts may be neither useful nor adaptive. As such research might profitably explore positive schizotypy in relation to creativity tasks that better reflect the complexity of the construct.

Perhaps a more thorny issue relates to the implications of the positive schizotypy-creativity link for conceptualisations of mental health and normative conscious experience. Rather than framing these links as evidence for a link between creativity and mental illness, for example, an alternative rhetoric draws upon the fully dimensional model of schizotypy. This perspective would model positive schizotypal experiences as normative that, under the right parameters, can lead to creativity and wellbeing. With this approach come potential clinical implications, where, drawing on the increasing evidence of the mental health benefits of engagement with the arts (including poetry, journaling, painting, crafting, coloring, singing) – artistic interventions might be developed to

help people with unhealthy experiences of schizotypy to self-regulate, manage, express, interpret and control these experiences, as well as experience joy and flow through engaging with the arts.

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Creativity in Science

When many people are asked about creative activities, they inevitably conjure up artistic creations: poems, novels, photographs, plays, sculptures, songs, etc. And if asked if they are creative they often say no precisely because they are not involved in such activities. Yet creativity is hardly the sole province of art. Creative thought and behavior happen in any and all domains of life, from cooking, building, and surviving to science. Indeed, science ranks up there with art as an occupation that would not exist if it were not for creative ideas and creative solutions to problems.

Although science requires as much creativity as art, its form and expression are somewhat different. Whereas artistic creations may involve often personal visions and emotional reactions to one's world, scientific creations involve ways to test our ideas about how the world works—and the world is not just the physical world, but rather the biological and social worlds as well. Creative insight is a must in science.

How is creativity in science manifested? The simple answer is nearly every aspect of science—from grand theory building to minute technical solutions to lab problems—involves creative thought. After all, as many other writers in this *Encyclopedia* have pointed out, creative thought and behavior must be both novel/original and meaningful/useful/adaptive. Therefore, **scientific creativity** is simply any thought or behavior in science that is both novel and meaningful to others; with creative thought or behavior in science being manifested throughout the scientific process, from theory construction and hypothesis formation, research and study design, to publication and communication of results. New and important discoveries in science come about often because of creative ideas and hunches of the scientists behind them. Of the thousands of new scientific articles being published world-wide each month, the vast majority of them are published precisely because they report some original finding, technique, or discovery. As Simonton argues, creativity in science is less and less manifested in the “lone genius” and more and more in the scientific team or laboratory, and indeed the lone scientific genius who creates new disciplines and revolutions may be over. To be sure, creativity in science occurs both at the individual and the group level. Either way, it is clear that science and creativity go hand in hand. What does the scientific literature have to say about the nature of scientific creativity?

The Science of Scientific Creativity

There is a newly established discipline that is well-situated to explore and uncover the nature of scientific creativity and that discipline is the psychology of science. The **psychology of science** is the scientific study of both implicit and explicit scientific thought and behavior. As Feist argued in *The Psychology of Science and the Origins of the Scientific Mind*, psychology is the only study of science that examines scientific thought and behavior from an empirical and even experimental perspective. Hence, the psychology of science is well-situated to uncover the nature of scientific creativity. The psychology of science empirically focused on at least

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four major elements of creativity in science: neural complexity, development of scientific talent and achievement, personality traits of highly creative scientists, and creative cognition in science.

Neural Complexity

One of the more exciting recent perspectives on creativity is the neuroscientific perspective. Each year, our understanding deepens as to the neural foundations of creative thought, including scientific creativity. One general conclusion from this research is the brains of creative people are often marked by more complex and more highly interconnected neural circuits than those of less creative people. That is, highly creative people appear to have greater neural connectivity between all major associative regions of the brain. Such a finding would be consistent with one of their most consistent and robust abilities in the creativity literature, namely, that creative people generate many more ideas, and the ideas they generate are looser and more remote in their associations. They are more cognitively fluent. This may be so because of a brain that simply has more connections, making rich associations more likely. Idea generation is as much about making connections as anything. Indeed, the frontal lobes themselves may well be especially important in this overall greater neural connectivity given the frontal lobes do more to connect various regions of the brain than any other lobe.

The neurological condition known as synesthesia appears to be related to creative associations. Synesthesia occurs when two or more of a person's sensory modalities (taste, smell, touch, seeing, and hearing) get mixed. For example, a synesthete may experience colors when perceiving numbers or smell words. More than a few of our most creative scientists, inventors have had synesthesia, including Richard Feynman, Daniel Tammet, and Nikola Tesla. One compelling theory for synesthesia put forth by Ramachandran and Hubbard is that it results from a cross-wiring or cross-activation of sensory neurons in various parts of the brain such that, for instance, brain regions involved in color perception get cross-activated with sensations of numbers. Some extraordinary mathematical ability results from synesthetic perception of number, as most clearly seen in the savant Daniel Tammet. Creativity and synesthesia share neural complexity in common.

Development of Scientific Talent

Research into talented and gifted high school students who compete in and win national and international science competitions makes clear that achievement in science starts with a unique combination of intelligence, drive, emotion, and personality of students as they navigate the world of world-class—and competitive—science. Indeed, a critical question examined by psychologists of science is a developmental question: Where does scientific creativity come from? Like all creative achievement, scientific talent has a life-span trajectory. Certain children, based on a combination of talent and training, are more likely to go into science than others, and even particular kinds of science than other kinds. But going from childhood interest to adult scientific achievement is a long and complex process. Many obstacles and life circumstance intervene and many potential scientists change career paths. Moreover, once a scientist, there is a wide range of creative ability and the focus in this chapter is on creative talent and achievement in science. What, then, are the psychological factors behind creative talent and achievement in science and how do these factors change across the lifespan? Taken as a whole, the literature on these questions does provide some pieces to the puzzle of scientific productivity.

Scientific Creativity and Talent Across the Lifespan

Historically, the first scientific work on the development of scientific talent and creativity develops was conducted by Francis Galton in the 1870s. Most relevant to the current chapter, Galton's book *English Men of Science* in 1874 pioneered work on birth-order and scientists and found that scientists were more likely to be first-born children than non-scientists.

The first systematic and longitudinal research program that shed light on the development of scientific talent was conducted by Lewis Terman, beginning in the 1920s. His study included children if they had tested IQs of 140 or higher. More than 1500 children qualified and participated, with the first sample being tested in 1921 (when most of the children were about 10 years old). They were assessed once or twice a decade for the next 60 years. By following the cohorts over their entire adult lives, Terman and his colleagues were able to answer the important question of what happens to our brightest children. Do they go on to very productive and creative careers? The answer is "yes" to productive, but "not really" to creative. Although the sample as a whole achieved higher than normal levels of education and career success, if one uses standard creativity criteria (impact, productivity, and honors and awards), the Terman group in general was surprisingly uncreative over the course of their careers. No major writers, artists, or scientists emerged from this 'genius' level IQ group. Indeed, two future scientists who were tested by Terman—William Shockley and Luis Alvarez—but did "not make the cut" went on to outperform any of the Terman subjects by receiving Nobel prizes in physics.

The next major longitudinal investigation that focused even more closely on scientific talent development was begun by Julian Stanley at Johns Hopkins in the 1970s and has continued under the leadership of Stanley's students Camilla Benbow and David Lubinski, now at Vanderbilt University. The project is known as the Study of Mathematically Precocious Youth (SMPY) and it targets children under the age of 13 who show precocious signs of mathematical talent. Results from these studies have reported that precocious ability does predict achievement in high school and in college. More recently, Benbow and colleagues reported that approximately 90% of the SMPY sample go on to earn bachelor's degrees, slightly less than 40% get master's degrees, and about 25% receive doctorates. These figures are well above the base-rates for such degrees in the general population (with 23%, 7%, and 1% being the national figures respectively). Similarly, Lubinski and colleagues reported in 2006 that talent-search SMYP participants who scored 700 or above on either one of the SAT subscales (quantitative or verbal) before age 13 went on to have very successful careers 20 years later, especially in math, science, or engineering. For example, nearly half of them were

post-secondary teachers, scientists, or engineers. More specifically, about 15% of the talent-search females and about 9% of the talent-search males were in tenure track or tenured positions by age 33—rates much higher than the general population.

Most directly relevant to scientific creativity and talent, Rena Subotnik and her colleagues were the first psychologists to systematically examine the longitudinal paths of scientifically talented young people. She focused on finalists and semi-finalists for the country's most prestigious and elite science talent search competition, the so-called Westinghouse competition (now known as the Intel competition). It involves more than 1500 high school juniors and seniors every year, of which the top 300 are semi-finalists and the top 40 are finalists. Subotnik followed up one cohort of semi-finalists from 1983 and were able to collect data on approximately 100 of the 300 finalists/seminfinalists. Eight years after being semi-finalists and finalists, 49 of the 60 males (82%) but only 25 of the 38 females (66%) were still in science or science related fields (including graduate school. Moreover, as Joseph Berger has reported on the entire sample of Westinghouse finalists, they do garner awards and recognition for their continued excellence for scholastic and career achievements. For instance, in the entire population of finalists up through 1994 five have gone on to earn Nobel prizes, 28 have become members of the National Academy of Sciences, and at least eight MacArthur Fellows have been awarded.

A few researchers have addressed the question of who is likely to make significant contributions to science and if so did they show early signs of their talent. Feist, for instance, examined the development of scientific interest in Westinghouse finalists and members of the NAS. For Westinghouse finalists, both men and women knew science was for them at an equally young age—by age 12. Members of the National Academy also developed an interest in science at a very early age, with 25% knowing they wanted to be a scientist by age 14%, 50% knowing by age 18%, and 75% knowing by age 20. In terms of first realizing they had talent for science, 25% of the NAS members realized their talent by age 13%, 50% by age 16%, and 75% by age 21. The range was ages 5 to 33. Finally, NAS members began doing science early, with 75% having participated in formal research by age 21, and no gender difference between men and women. Half of the NAS members had published a scientific article by age 23, and at least one member had published by age 16. Those who go on to have real talent in science as adults seem to realize at a young age that they want to become a scientist. Given that most college students change their major many times during their 4 years as an undergraduate, to have a group know by the end of high school or before that a particular career is right for them is quite remarkable. Early and clear insight into one's career calling is often an indicator that one knows where one's talents lies, and indeed such "crystallizing experiences," as Howard Gardner has called them, are frequently seen in adolescents who go on to be our most creative adults.

Age and Scientific Productivity

The oldest and most established question concerning the development of scientific productivity is of growth curves and publication rates, that is, how productivity (i.e., publication rates) changes with age. As Dean Simonton has often reported in his reviews of the literature, the findings have converged on the conclusion that the relationship between age and productivity in science (and other professions) is curvilinear: Scientific productivity increases steadily over the first 20 years of a scientist's career, plateaus, and then gradually declines. In other words, it forms an inverted-U.

Similarly, in a study of National Academy of Science (NAS) members Feist reported three unconditional growth curve models that were constructed to test Simonton's curvilinear model of age and productivity, namely a linear model, a quadratic model, and a cubic model. Each model provided a close fit to the data, suggesting that publication rates increase over time. Out of the three models, however, the curvilinear model provided a better fit than the linear model, and the cubic model a better fit than the curvilinear model. In other words, a model with two peaks (approximately 20 years into one's career and then again at the very end) was the best model of age and productivity.

Related to age and productivity there is the question of whether early recognition of talent and producing works early in life predicts later levels of productivity. The empirical consensus is that early levels of high productivity do regularly predict continued levels of high productivity across one's lifetime. Those who are prolific early in their careers tend to continue to be productive for the longest periods of time.

Lastly, there is also the question of whether the age at which one's talent for science is first expressed predicts lifetime achievement in science. Regarding age of recognized talent, Feist predicted that in a sample of NAS members, age of talent should predict age of publishing and obtaining the PhD, which in turn should predict productivity and impact. Results showed that the four precocity variables were modestly positively correlated with age of first publication, which is an intermediate variable between precocity and achievement. In other words, the younger NAS members were when they and others recognized their scientific talent, when they wanted to be a scientist, and when they first conducted scientific research, the younger they were when they published their first paper. Age of first publication in turn predicted total publication rate over the lifetime, meaning the earlier one publishes the more productive one will be. This pattern of relationships—from precocity to age of first publication to lifetime productivity—implies an indirect connection between precocity and publication rate. The only precocity variable that predicted lifetime productivity was age that one first conducted formal research.

Creative Personality in Science

The development of scientific talent, achievement and productivity over the life course is one focus of psychologists of science who are interested in scientific creativity. Another focus is the unique personality characteristics of highly creative scientists.

One model of personality that explains the connection between personality traits and behavior, including scientific creativity, is the so-called functional model of personality. The basic idea of this model is that traits function to lower behavioral thresholds. If a person has a particular trait, then corresponding behaviors are more likely (have lower thresholds) in given situations. A person with a friendly personality, for instance, is more likely to behave in a friendly and warm way than a person without such a trait.

Applied to creative behavior, certain personality traits make creative thought and behavior more likely. What then are these personality traits, in particular as they relate to scientific creativity? A meta-analysis published in 1998 by Feist addressed the question of which traits make creativity and eminence in science more likely and what their magnitude of effect was (see Karwowski and Lebeda for a recent qualitative review of the general creativity and personality literature). The traits can be arranged into three psychologically meaningful categories: cognitive, motivational, and social.

Cognitive Traits

A consistent finding in the personality and creativity in science literature has been that creative and eminent scientists tend to be more open to experience and more flexible in thought than less creative and eminent scientists. The few studies that reported either no effect or a negative effect of flexibility in scientific creativity used student participants. For instance, in 2003 Feist and Barron examined personality and creative achievement in a 44-year longitudinal study. More specifically, they found that personality variables (such as Tolerance and Psychological Mindedness) explained up to 20% of the variance over and above Potential and Intellect. Specifically, two measures of personality—California Psychological Inventory scales of Tolerance (To) and Psychological Mindedness (Py)—resulted in the 20% increase in variance explained (20%) over and above potential and intellect. The more tolerant and psychologically minded the student was, the more likely he was to make creative achievements over his lifetime. Scott Kaufman and colleagues recently reported that more than openness (cognitively engaging with fantasy, aesthetics, and emotions) more the intellect dimension of openness (i.e., cognitively engaging with semantic and abstract information) that is more closely associated with scientific creativity. (See Cognition)

Motivational Traits

The most eminent and creative scientists also tend to be more driven, ambitious, intrinsically motivated, and achievement oriented than their less eminent peers. Busse and Mansfield, for example, studied the personality characteristics of 196 biologists, 201 chemists, and 171 physicists, and commitment to work (i.e., “need to concentrate intensively over long periods of time on one’s work”) was the strongest predictor of productivity (i.e., publication quantity) even when holding age and professional age constant. Similarly, Helmreich and colleagues studied a group of 196 academic psychologists and found that different components of achievement and drive had different relationships with objective measures of attainment (i.e., publications and citations). With a self-report measure, they assessed three different aspects of achievement: “mastery” preferring challenging and difficult tasks; “work” enjoying working hard; and “competitiveness” liking interpersonal competition and bettering others. Helmreich and his colleagues found that mastery and work were positively related to both publication and citation totals, whereas competitiveness was positively related to publications but negatively related to citations. Being intrinsically motivated (mastery and work) appears to increase one’s productivity and positive evaluation by peers (citations), whereas wanting to be superior to peers leads to an increased productivity, and yet a lower positive evaluation by peers. The inference here is that being driven by the need for superiority may backfire in terms of having an impact on the field. (See Motivation)

Social Traits

In the highly competitive world of science, especially big science, where the most productive and influential continue to be rewarded with more and more of the resources, success is more likely for those who thrive in competitive environments, that is for the scientists who are self-confident, dominant, arrogant, and hostile. Bruno Lemaître, a geneticist who carried out three studies that won a Nobel Prize—only to see the prize go to head of the lab and not him—argues for the power of narcissism, need for power and visibility, in high level science. Similarly, Feist in the 1990s reported a structural equation model of scientific eminence in which the path between observer-rated hostility and scientific eminence was direct and the path between arrogant working style and eminence was indirect but significant.

The scientific elite also tend to be more aloof, autonomous of social influence, asocial, introverted and have more of an internal locus of control than their less creative peers. In a classic study from the 1950s concerning the creative person in science, Anne Roe found that creative scientists were more achievement oriented and less affiliative than less creative scientists. Recently, Kirsch and colleagues reported that need for autonomy was strongest personality predictor for creativity in the social sciences (psychology and education).

To summarize the distinguishing traits of creative scientists: they are generally more open and flexible, driven and ambitious, and although they tend to be relatively asocial and autonomous, when they do interact with others, they tend to be somewhat prone to arrogance, self-confidence, and hostility.

Creative Cognition in Science

As Ryan Tweney wrote: Science, by its very nature, is a cognitive act. We could add that creativity, by its nature, is a cognitive act. Hence, creativity in science inevitably must involve unique and consistent cognitive processes and strategies. It does and psychologists of science have concluded that at least four cognitive processes are consistently involved in scientific creativity, namely analogy, metaphor, visualization, and fluency and flexibility of association.

Analogy

Analogy involves seeing how something new (target) is like something old (source). Our mind seems to do this automatically and intuitively almost any time we are confronted with a new idea or new experience. Analogy is one of the more ubiquitous ways the brain takes sensory experience and gives it meaning. In *The Way We Think*, the cognitive scientists Gilles Fauconnier and Mark Turner put it this way: "Analogy has traditionally been viewed as a powerful engine of discovery, for the scientist, the mathematician, the artist, and the child."

There is a well-developed literature on the importance of analogy and metaphor in scientific problem solving and creativity. The consensual conclusion from this literature is that analogy is a crucial problem-solving heuristic that allows scientists to apply schemas, models, and mental maps from known to unknown domains in order to solve problems. The success and richness of the analogy depend on how deep the similarity is between old and new. Associations no doubt play a critical role in analogical thinking, with the similarity being touched off via an association. In science, these analogies also often serve as the foundation for hypotheses.

Let's look at one of the most powerful scientific analogies in the history of science: Darwin's tree branch analogy and evolution. Species that are more closely related are closer together on a common branch. This branching analogy is used in current taxonomic systems. The branching tree analogy also makes clear that evolution is not a linear progressive process with humans at the apex, as many evolutionists at the time had argued. Rather, evolution consists of many dead ends and extinct species and is simply a process of the birth, growth, and death of species, all going back to one common origin. This was a truly powerful and revolutionary insight: *all life* on the planet is related! Another foundational analogy used by Darwin was the comparison between natural selection and artificial selection seen in human breeding of plants and animals. Indeed, Darwin's first chapter to *Origins* begins with the well-known principles of "Variation under Domestication," which lays the foundation for using similar principles in nature in the next chapter, entitled "Variation under Nature."

Analysis of historical cases also consistently reports creative scientists often use analogies to solve problems. In *Psychology of Science: Contributions to a Metascience*, Dedre Gentner and Michael Jeziorski compared the way two physical scientists (Robert Boyle and Sadi Carnot) used analogies to the way alchemists employed them. They concluded that following particular rules when using analogies (for example, avoiding mixed analogies, understanding that analogy is not causation) was the key to distinguishing scientific from pseudoscientific reasoning. But Carnot and Boyle had different styles of analogical reasoning: the former relied on a single analogy, deriving principles from it, whereas the latter preferred to work with a whole family of analogies. Similarly, Nancy Nersessian observed that James Clerk Maxwell used analogies iteratively, that is, he constantly modified them to fit his growing understanding of the constraints of the target domain. Michael Gorman has demonstrated that Alexander Graham Bell deliberately "followed the analogy of nature" and used the human ear as a mental model for his telephone; like Maxwell, he was able to modify this analogy as he learned more about his target domain.

Metaphor

Metaphor is similar to analogy in that they both involve applying similarity from an old source to a new target. In this sense many metaphors are analogies. The essence of metaphor is an "as if" comparison, thinking about X as if it were Y. By applying one phrase or idea to another different one that is not literally the same, we again make the unknown known.

As psycholinguists as George Lakoff, Mark Johnson, and Steven Pinker have made clear, metaphors are so ubiquitous that we often do not even recognize the metaphorical nature of much of our thought. For instance, Pinker gives the following examples of the metaphorical use of *went*: "the messenger went from Paris to Istanbul," "the inheritance went to Fred," "the light went from green to red," and "the meeting went from 3:00 to 4:00." Only in the first phrase is *went* used literally to mean moving from one place to the other. In each of the other instances, *went* is used metaphorically. Our minds seem well equipped to make such connections and to transfer similarities as a way of understanding the new and unknown.

It is no surprise, therefore, that science is replete with metaphors. Indeed, most major scientific insights have involved some kind of analogical metaphor. Robin Dunbar has pointed out that metaphorical use of language is especially rampant in particle physics and evolutionary biology. Particle physicists refer to the different kinds of quarks as "top," "down," "bottom," "up," "charmed," and "strange." Such everyday common words could hardly be more literally removed from the abstract, unobserved, and probably unobservable quarks, and yet that is part of the joke or pun of the inventors of these terms. Mathematicians also commonly refer to equations as "beautiful," or "well behaved." Evolutionary biology is also littered with such metaphors: "the selfish gene," "kamikaze sperm hypothesis," or the "red-queen hypothesis" (from Alice in Wonderland), just to name a few. I would also point out that computer science is perhaps even more prone to metaphor: "user-friendly," "mouse," "crash," "boot-up," "file" "window," and so on. As Dunbar goes on to argue, however, there is good reason for such widespread use of metaphor in these fields: they are far removed from everyday experience and we simply have no words to describe the phenomena. Therefore, scientists have little choice but to either use metaphors or invent new technical terms. Sometimes scientists do the latter, but more often than not they choose the former, and the terms "strike us" as "warmer," and "friendlier" than technical jargon (note the metaphorical use of these words).

Metaphor and analogy are common in and out of science precisely because they are so useful to hypothesis and theory formation, thought experiments, creativity, and problem solving. They provide useful constraints to solutions to problems by focusing strategies and preventing random and fruitless searches for a solution. Scientists, and especially the best scientists, tend to use them more readily than novices and thereby go down fewer dead ends when trying to solve a problem. Of course, analogies and metaphors offer such cognitive advantage only if they are appropriate and useful. Often the more creative scientists have

a feel for (that is, an intuition for) a good and productive analogy or metaphor. When they are useful, they make problem solving much more efficient than it would be otherwise.

Visualization

Another cognitive strategy or heuristic often used in but not unique to scientific creativity is visual imagery. The historian of science Arthur I. Miller in his book *Insight of Genius* and elsewhere has written at great length about the important role of visualization and imagery in science. After detailing case after case in the history of physics, he summarized his main point about the role of visual imagery in creative scientific thinking: visual imagery plays an important role in scientific creativity (for example, Einstein's thought experiments) and in scientific advance, and it can carry truth value (for example, Feynman diagrams).

Einstein is one of the more noteworthy examples of the importance of visual thinking. The gestalt psychologist Max Wertheimer spent hours and hours interviewing Einstein in 1916 about how his theory of relativity came about, and among other things, Einstein remarked that he rarely thought in words and used words only after the idea came to him so that it could be communicated to others. The physical world after all is made up of objects and the ability to think in images would be of great help in solving physical problems. Visual intuition, to be sure, was crucial for all of Einstein's great insights: imagining himself traveling at the speed of light, imagining himself simultaneously jumping off of a roof and dropping a stone (which led to his insight that gravity and acceleration are relative quantities), and imagining two observers riding on either the northern or southern pole of a magnet. Most of these visual thought experiments occurred in the twenty-year period between 1895 and 1915, and by all accounts this was the period of Einstein's singular creative genius. In fact, other physicists such as Richard Feynman remarked on the lack of creativity in Einstein's later life being connected to his decline in his use of visual imagery.

Physics as a whole became less comprehensible when it moved beyond what we observe in everyday life and can easily visualize. Quantum mechanics is the prime example because it deals with matter at a fundamentally different level than the observable Newtonian world. From about 1925 (with the death of Bohr's "atom as solar system" model) until 1949, quantum physics moved decidedly away from the use of visual images and toward purely mathematical formulations. In Niels Bohr's 1922 Nobel prize lecture, the limitations of his own model were already clear to him: "We are therefore obliged to be modest in our demands and content ourselves with concepts which are formal in the sense that they do not provide a visual picture of the sort one is accustomed to require." In 1949, however, Richard Feynman was to change this by advancing his graphic "Feynman diagrams" to explain how subatomic particles interact. As quoted in Gleick's biography *Genius*, Feynman described what he was doing with Feynman diagrams: "What I am really trying to do is bring birth to clarity, which is really a half-assedly thought-out pictorial semi-vision thing. I would see the jiggle-jiggle-jiggle or the wiggle of the path. Even now when I talk about the influence functional, I see the coupling and I take this turn—like as if there was a big bag of stuff—and try to collect it away and to push it. It's all visual. It's hard to explain." Most recently, string theory has added concreteness to a concept that right now is orders of magnitude away from being observed, namely, "strings." Strings are an excellent example of both how visual images and metaphor are used in the construction of scientific theory.

Fluency and Flexibility of Associations

In addition to the cognitive processes already discussed (analogy, metaphor, and visualization), a number of cognitive traits cluster around creative ability: remote and loose associations, over-inclusive and disinhibited thinking (latent inhibition), fluency, flexibility, novelty and originality. Sarnoff Mednick's theory of remote associations underscores the associational richness of creative thinkers. J. P. Guilford built a theory of creativity around ideational fluency, flexibility, and originality, arguing that creative thinking results from having many ideas (fluency) that cross boundaries and categories (flexibility) and that are novel and original. Hans Eysenck proposed that the defining cognitive characteristic of highly creative individuals, besides at least a moderately high level of intelligence, is their over-inclusive and disinhibited thinking. In other words, creative people automatically have a wider range of associations and have difficulty inhibiting associations and focusing on a narrow range of relevant stimuli. For this reason, they score high in what Eysenck called "psychoticism." Finally, Dean Simonton, borrowing from Donald Campbell, put forth the chance configuration theory of creativity, which posits that ideational and associational fluency are the foundation for creative thought. In a very Darwinian fashion, ideas are first generated in great number (variation), get combined (chance permutation), and those permutations that are adaptive and useful get selected and reproduced (retention). Just as in biological natural selection, some ideas are adaptive solutions ("hits") and these get selected and retained, whereas others are not adaptive or useful ("misses") and these do not survive. Creative scientists, like all creative people, are able to produce a richer and deeper set of associations, many of which are not useful, but some of which are. These survive and become the foundation for creative ideas in science.

Conclusion

Science would not exist if it were not for the creative ideas of its participants. The psychology of science has empirically addressed and answered the questions of who becomes interested in and has talent for creative science. The answers provide particular profiles of neural complexity, development, personality, and cognition. This chapter summarizes these literatures and provides an integrated profile of the creative scientist. For example, the creative scientist compared to the less creative scientist is called to the life of science at a younger age, remains highly productive, is more confident, asocial, flexible, and hostile, and solves problems more often using analogy, metaphor, and visual imagery.

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Self-actualization[☆]

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Glossary

Authenticity Behavior that is a true reflection of one's self. An indicator or outcome of self-actualization. It is also a criterion of creativity in many Eastern views where authenticity is more important for creativity than originality.

Divergent thinking The capacity to generate ideas, many of which are original. Tests of divergent thinking are used in correlational studies of self-actualization and creativity, though divergent thinking only represents a potential to be creative. It is not a guarantee.

Intrapersonal intelligence A specific domain of talent, increasingly recognized in creative studies, which in many ways parallels self-actualization.

Self-actualization Openness to and acceptance of one's true self. Leads directly to openness to experience, spontaneity, and creativity. Self-actualization is the epitome of psychological health.

Theories of Self-actualization

Self-actualized individuals are thought to be creative. Abraham Maslow, for example, felt that self-actualization and creativity are interdependent. He described how creativity facilitates self-actualization and self-actualization facilitates creativity. In Maslow 1971 even concluded that creativity and self-actualization “may turn out to be the same thing” (p. 57).

Carl Rogers, another leading humanistic psychologist, argued that:

the mainspring of creativity appears to be the same tendency which we discover so clearly as the creative force in psychotherapy – [a person's] tendency to actualize ... to become one's potentialities... the individual creates primarily because it is satisfying... because this behavior is felt to be self-actualizing. (1961, pp. 351–352)

Empirical Research on Creativity and Self-Actualization

Rogers and Maslow developed their theories of self-actualization by drawing from their experience conducting psychotherapy. Such work gave them extensive information about individuals; however, generalizations from clinical observations are often questioned. This is because (a) generally a small number of persons are observed, and (b) those persons may be atypical in many ways – after all, they are receiving psychotherapy. Fortunately, more rigorous research followed the propositions of Rogers and Maslow and also examined the relationship between self-actualization and creativity.

Some of this research failed to support the relationship between creativity and self-actualization. For instance, nonsignificant (and low) correlations were between four measures of creativity and self-actualization, the former operationalized with the Remote Associates Test (RAT), and the latter with the Personal Orientation Inventory (POI). These results are not entirely convincing, however, in part due to the measure of creativity used. The RAT may be verbally biased, for example, and in this research its reliability was in the range between 0.51 and 0.67, which is marginal at best. Convergent validity coefficients were similarly marginal

[☆] *Change History:* August 2019: Mark Runco extended the glossary. New research was added, including a discussion of how recent discussions of definitions of creativity should include authenticity, as well as originality and effectiveness, in order to capture Eastern views. The update also clarified the testing issues involved in studies of self-actualization and tweaked the view of the creative process.

This article is an update of M.A. Runco, Self-Actualization, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 335–336.

($0.01 < r_s < 0.48$), which can be indicative of dubious construct validity. The point is that the lack of a relationship between creativity and self-actualization may reflect the measures employed.

Some researchers have operationalized creativity with the Torrance Tests of Creative Thinking (TTCT), which are quite widely recognized as a reliable estimate of the potential for creative problem solving. They are unlike the RAT in that they examine the capacity for divergent thinking and the production of idea. Note the emphasis on potential; no test of creativity guarantees actual creative performance. Tests are samples and at best accurately predict future behavior. Note also the emphasis on problem solving. Some creativity may be more self-expression than problem solving – and this may be especially true of the creativity that is related to self-actualization. Yet another measure of creativity used in this line of research was the Similes Preference test.

Murphy et al. (1976) found that Personal Orientation Inventory scores were significantly and positively correlated with the elaboration index from the TTCT. They did not provide the actual correlation coefficient, so it is impossible to really interpret the relationship. POI scores were unrelated to the originality fluency TTCT scores, and were unrelated to performances on the Similes test. The result with originality is disconcerting because it is usually taken to be the key ingredient of creativity.

Runco and his colleagues noted that the relationship between creativity and self-actualization could only be accurately assessed if creativity was operationalized in terms of personality and process. These reflects two common perspectives on creativity. The personality approach posits that there are core characteristics or traits that are functionally associated with creative behavior [see Personality]. The process orientation posits that creativity may not result in tangible products but should be understood as something that is protracted and occurs over time.

Maslow was explicit about the distinction between personality and product:

SA [self-actualized] creativeness stresses first the personality rather than its achievements, considering these achievements to be epiphenomena emitted by the personality and therefore secondary to it. It stresses characterological qualities like boldness, courage, freedom, spontaneity, perspicuity, integrity, self-acceptance, all of which make possible the kind of generalized SA creativeness, which expresses itself in the creative life, or the creative attitude, or the creative person. I have also stressed the expressive or Being quality of SA creativeness rather than its problem-solving or product making quality (1968, p. 145).

Maslow later gave these traits when defining self-actualization: acceptance of self, others, and nature; detachment; a desire for privacy; autonomy; resistance to enculturation; problem-centering; and democratic character structure. Most of these are also characteristic of the creative personality.

Runco and his colleagues used two well-respected measures of the creative personality: the How Do You Think Test (HDYT) and the Adjective Check List, which has a Creative Personality scale. They also administered the Self-Actualization Scale (SAS). Four scores were derived from the HDYT responses, and each was significantly and positively correlated with the SAS scores. It thus appears that the relationship between creativity and self-actualization does indeed depend on the measures employed. In particular, the results underscored the need to measure creativity with personality traits, at least when the interest is self-actualization. Importantly, although the findings were contrary to the other two empirical studies on this topic, they were consistent with the observations of Rogers and Maslow. This suggests that the findings are trustworthy because they were predicted first by theory and then confirmed with empirical tests.

Lynne Buckmaster and Gary Davis (1985) also reported a positive and significant correlation ($r = 0.73$) between self-actualization and a measure of creative personality traits. In particular, Buckmaster and Davis uncovered a creativity factor that accounted for a significant portion of variance in an eight-factor factor analysis. This analysis included the Reflections of Self and Environment (ROSE) measure, which is a self-report focusing on self-actualization. There are two questions with this factor analysis: First, the creativity factor accounted for only 18.9% of the variance in the scores, perhaps because it was a fairly select sample of subjects. The participants were all students in a creativity course. This may have restricted the range of scores. It was also a relatively young sample of participants, which is an issue because self-actualization might require some experience and maturity. There is a debate in the psychological literature about the possibility of self-actualization in young persons. The second question concerned the ROSE index, which was more correlated with the creativity scores than it was with the POI scores ($r = 0.26$).

The low correlation with the POI again raises the issue of construct validity. Still, by and large these results were consistent with those of Runco and his colleagues which were summarized above. Thus in the two studies that relied on personality measures a positive and significant correlation was found between creativity and self-actualization.

The Adjective Check List was mentioned above and used in some of the personality research. It is a self-report containing 300 adjectives. Respondents indicate which adjectives are self-descriptive. The vast majority of persons whose self-actualization scores were in the top 25% of the sample used these adjectives to describe themselves: Adventurous, Alert, Appreciative, Clever, Dependable, Friendly, Helpful, Honest, Loyal, Active, Adaptable, Capable, Easy-Going, Formal, Humorous, Intelligent, Interests Wide, Kind, and Mature. None of them described themselves as Commonplace, Conceited, Cruel, Despondent, Distrustful, Dull, Gloomy, Queer, Slipshod, Stolid, Sulky, Unintelligent, Unkind, or Unstable. These are interesting but socially desirable responding was possible.

Creativity, Health, and Possible Underlying Causes

Both creativity and self-actualization are indicative of psychological health. As is the case with most signs of health, however, it is not easy to determine which comes first. It is possible that self-actualization allows the individual to be creative, or that the creative

tendency supports self-actualization. It is also possible that both are results of a third variable. This third variable might be the capacity for effective coping, adaptability, or intrapersonal intelligence. Recall here what Rogers said, and was quoted earlier, that self-actualization and creativity both reflect an underlying motivational force. Intrapersonal intelligence is included in this discussion because it is one of the distinct domains from Howard Gardner's well-known framework. The other domains are inter-personal, verbal, mathematical, spatial, bodily-kinesthetic, musical, and naturalistic. Gardner goes into some detail about the unique processes underlying each of these domains, including the intrapersonal domain.

Authenticity is a good candidate for a third variable that leads to both creativity and self-actualization. Authenticity is associated with a low level or lack of self-censorship, as well as a resistance to conformity. As a result the individual expresses his or her true self. The resistance to conformity and lack of self-censorship can both facilitate creative behavior. Self-actualization is impossible without authenticity. The individual is a unique individual, with good and bad tendencies, and the only way to self-actualization is through the acceptance of both. A lack of self-censorship is again useful, if not vital.

One interesting thing about authenticity is that in the past decade various researchers have argued that it is more important for creativity than is originality, at least in Eastern Cultures (Khurkhurin, 2014; Tan, 2016). Including authenticity in a definition of creativity therefore gives is more cross-cultural validity, and this definition would be entirely aligned with the humanistic view of creativity, which also includes authenticity.

It does appear that some creative persons are not self-actualized. Some are certainly not healthy. In fact, creativity can be downright destructive [see Destructive Creativity] and, as Robert McLaren (1993) argued, there may be a dark side to creativity [see Dark Side of Creativity]. This may be manifested in creative but destructive discoveries and inventions, such as thermonuclear weapons, and in the not uncommon self-destructive behaviors of some creative persons. This self-destruction may take the form of suicide or alcoholism.

Conclusions

There is evidence that creativity and self-actualization are related. This relationship was predicted by the theories of Carl Rogers and Abraham Maslow and was apparent in both clinical observations and, later, at least two correlational studies. As is the case with all correlations studies, however, there is some uncertainty about the direction of effect: creativity may lead to self-actualization, or self-actualization may support creativity. They may both reflect a third variable, such as coping or adaptability. And neither guarantees the other.

There are many cases of unhealthy creative persons. This is not much of a surprise because there are many different ways to be creative. Rhodes went into some detail about this when she distinguished "deficiency creativity" from "being creativity." People are creative for varied reasons. In addition, some individuals are creative in their work, and some in their leisure (See Everyday Creativity). Some are creative when they solve problems; others are creative only when they are not threatened by problems. Although some creative persons may be self-actualized, and that self-actualization may in fact be necessary for their creativity, other individuals may be creative without self-actualizing. Both creativity and self-actualization are multifaceted constructs, and this gives them any number of possible intersections.

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Serendipity

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Introduction

The word “serendipity” commonly refers to making a discovery by chance and sagacity when one was looking for something else and—by extension—the capacity and the art of making a discovery in unexpected circumstances. This accidental meeting offers an opportunity for the reorientation and development of new objectives, exploration of unexpected results, and transformation or creation of new theories or practices.

There are numerous examples of serendipitous discoveries in many disciplinary fields: penicillin, laser, aspirin, X-rays, radioactivity, Viagra, Post-It, nylon, Kevlar, the stethoscope, jeans, Coca-Cola, abstract painting, the hot air balloon, and the Tatin tart. This list of serendipity cases shows the richness and extent of a phenomenon that has common relevant traits beyond the diversity of cases and contexts. Far from being a simple buzzword or marginal and peripheral phenomenon, serendipity is an essential mechanism in the creative processes of research, discovery, theoretical construction, and practical action. Starting from the origin of the concept of serendipity, this article proposes a definition of the phenomenon as a creative process. The characteristics of the serendipitous process, the resulting products, the people who shape them, and the role of the context are then presented. The transdisciplinary dimension of serendipity is then highlighted. This transdisciplinarity finally links up with the indiscipline inherent to serendipity.

Origin

The word “serendipity” has its source in the literary field. It was coined by the British writer Horace Walpole (1717–97), in a letter written on January 28, 1754, to his friend Horace Mann. Serendipity refers to unexpected discoveries, made by accident. Walpole was explicitly inspired by the title of a tale of Persian origin by Amir Khusrau (1253–1325) that he had read as a child in the version by Louis de Mailly entitled *Travels and Adventures of the Three Princes of Serendip* (1722). During their adventures, the heroes multiply unexpected discoveries of things that they described them on the basis of clues without ever having seen them (Van Andel and Bourcier, 2009). Walpole invented the word “Serendipity” from the old Sri Lankan name “Serendip,” from Persian *Sarandip* and Arabic *Sarandib*. It was relatively dormant until it was introduced in sociology of science by Merton in 1945 in his article *Sociological Theory* (Merton, 1945). This conceptual awakening reactivated the notion by making it an important element of the research process underlying accidental discoveries, chance, or wisdom of valid results that were initially not wanted.

Merton clarified his thought in a new article in 1948 (Merton, 1948) and in a work cowritten with Barber in 2004, *The Travels and Adventures of Serendipity* (Merton & Barber, 2004). A “serendipity pattern” designates a mechanism in which the observation of unanticipated, abnormal, and strategic data becomes an opportunity to develop a new theory or expand an existing theory. The idea of unanticipated data or unexpected results opens the possibility of observing or even producing accidental and unforeseen results at the start of the research process.

Serendipity can be defined as a complex and varied phenomenon including the process of its genesis (between chance and its shrewd exploitation), the final product resulting from this process (cases and facts of serendipity), as well the ability or the art of making an unexpected discovery. A process, a product, and an ability are three key ingredients that help identify serendipitous production.

Process and Product

As a creative process, serendipity is characterized by a double movement: first an unexpected discovery that emerges by chance in the course of research or a planned action, then in a second phase the understanding and use/exploitation of this unforeseen element to draw a new idea, hypothesis, theory, or practice likely to reconfigure more or less radically the work in progress. Serendipity is not simply chance, nor an isolated stroke of genius or a “eureka” suddenly imposing a solution; it implies in a complementary way the wise, original, and relevant exploitation of an unexpected discovery. Diverting attention/focusing on the seemingly determined search for something, chance is not perceived as a negative and irrational effect to neglect or eliminate from the current process, but on the contrary positively as a heuristic opportunity to explore and exploit creatively new avenues for research. Serendipity enacts the double mechanism at work in a creative process (Guilford, 1956): the divergence phase (in this case triggered by an unforeseen and happy accident) that allows the exploration of new ideas and possibilities, and the convergence phase that aims at the original, intelligent, synthetic, and adapted exploitation of these new lines of thought. Accidental divergence–exploration offers the opportunity to take a step aside from the deterministic linearity of a conventional research approach, and convergence–exploitation allows the production of new ideas, hypotheses, or products.

Among the famous examples of discoveries and inventions made by chance and identified as cases of serendipity is the invention of Velcro by the engineer Georges de Mestral (1907–90). This case illustrates well the double movement of the serendipitous process. Georges de Mestral accidentally discovers something he was not looking for and derives a new idea and product from it. While walking his dog, he noticed that the burdock fruits cling to the hair of his dog and to his own socks. Not content to simply get rid of these burdock fruits to continue his journey, he begins an exploratory quest to examine them under the microscope and discovers that they are equipped with micro-hooks. This phase of study and exploration is followed by a more convergent phase of exploitation of this discovery with the idea of using this process of hooks that cling to a fabric, a nylon textile closure. The transition between the accidental discovery (in 1941) and the invention and innovation of the final product took 10 years to materialize in a patent (in 1955), following many experiments and attempts.

Velcro (a portmanteau word formed out of the words *velvet* and *hook*; in French “velours” and “crochet”: “qui s’accroche au velours”/which clings to velvet) is a typical case of bionics in the sense that it is inspired by the observation of a plant (in this case a micro-hook system) to draw, after questioning and analysis, a technical application by biomimicry. The double process of serendipity (chance encounter and exploitation of its potential) leads to products of invention and innovation subject to variation according to the case-types and the contexts. The example of Velcro is thus considered a typical case of “true serendipity” (Roberts, 1989) in the sense that the researcher made an accidental discovery of something that he did not specifically seek and which was not part of his current scientific concerns.

The inventions of microwaves, Lysergic acid diethylamide (LSD), or laminated glass are other examples of products resulting from ideas found by chance or by accident. These strong forms of serendipity in unexpected discoveries of ideas or things that were not sought are more nuanced in so-called pseudoserendipity cases according to Roberts (1989). These are certainly accidental discoveries, but which make it possible to achieve a desired goal by means other than those envisaged at the beginning of the research process. The researcher ultimately finds what he was looking for, but with an unexpected idea or means. After long efforts, the accidental discovery of the vulcanization process by Goodyear is a good example of pseudoserendipity. Other examples are Francis Pettit Smith’s boat propeller and Canon’s inkjet printing.

Beyond the true, pseudo-, or false serendipity, this complex process is each time a question of the degree and variation in bringing into play of chance, accident, the unforeseen, awkwardness, negligence, or error, with more or less anticipated issues, ranging from unknown unknowns (things we do not know we do not know) or unknown knowns (things we do not know we know) to known unknowns (things we know we do not know). In the case of the known knowns (things we know we know), one leaves without doubt the specter of serendipity since the researcher finds what he sought without chance intervening.

This almost tautological situation in which a researcher finds what he is looking for or what already existed by the application of a preestablished method is similar—by pushing his logic to the extreme—to a case of *Zemblanity*. The concept of zemblanity was invented by William Boyd (1952–Present) in his novel *Armadillo* (1998) in reference to the island of New Zembla situated at the antipodes of the island of Serendip, now Sri Lanka. Contrary to the spirit of invention and creativity inherent in Serendipity, Zemblanity refers to the faculty of systematically and deliberately making unhappy, unlucky, and expected discoveries and bringing nothing new.

Ability: The Serendipitist

People who produced serendipity cases or who make themselves available for such unexpected events—i.e., “serendipitists” according to Van Andel and Bourcier (2009)—are often perceived as having certain more or less specific abilities. They are described as curious observers, sometimes distracted, intuitive, judicious, and flexible, of independent spirit and preferring the unpredictable and freedom to the marked and authoritarian ways of knowledge production. These cognitive abilities to control make it possible to draw a secondary benefit from chance or accidents then transformed into happy phenomena that produce invention, innovation, and novelty.

A serendipitist has similar characteristics to a creative person. According to a multivariate approach to creativity (Sternberg and Lubart, 1995), the serendipitist mobilizes, on the one hand, cognitive factors with his strategic intelligence and his prior knowledge

that allow him to make a correct interpretation of an unforeseen fact and, on the other hand, conative factors related to his personality traits, motivations, and emotions. In terms of cognitive capacity, when a case of serendipity occurs, the researcher expresses his or her creative potential by identifying an unexpected fact or element and being able to redefine/reorient the process and task being resolved. Through a selective encoding process, he can locate in the environment or knows more or less the immediate information or phenomena in an apparently distant/disjoint relationship with respect to his questioning or problem to solve.

The personality, recognized serendipitists share the conative characteristics of more creative people (Feist, 1998). As perceived through the examples and analysis given above, the person or persons engaged in a process of serendipity, beyond their confidence in their own skills and their perseverance in their reflection and the search for innovative solutions, are more open to new experiences and risk-taking than conformists who are satisfied with the pursuit of certain and preestablished protocols. They are also more tolerant of ambiguity by accepting, wishing, or even challenging situations, assumptions, ideas, or approaches that are ambiguous and uncertain by appropriately responding and being able to exploit the unexpected effect generated by ambiguity, complexity, and uncertainty. Beyond the intra- and interindividual variations, the openness, and the ability to think outside preconceived boxes, serendipity requires the commitment of individuals capable at a specific moment of disengaging themselves from the mainstream and conformist thought, showing individualism and distance to really be able to confront and exploit the unexpected.

This was the capacity shown by Alexander Fleming in 1928, by serendipity, when he discovered the antibiotic properties of *Penicillium notatum*. While many bacteriologists had previously been confronted with the phenomenon of mold, but had simply shed their cultures, Fleming was able to identify this unexpected collateral fact of mold in the Petri dishes in which it was growing staphylococcal cultures and learned from them to develop penicillin. This cognitive flexibility was also expressed through his ability to observe differences and similarities by analogy, association, metaphor, comparison, or selective combination. The process of selective combination is here particularly illustrative, insofar as it makes it possible to precisely link elements to create a new idea, orientation, or product. A creative process of "bisociation" (Koestler, 1964) is at work in this unexpected rapprochement between distant elements or thought patterns that intersect to bring out new ones. The solution developed by Gutenberg for printing mobile characters on paper comes to him around 1450 during a day of harvesting (a domain of knowledge and practices which are very distant and apparently unrelated), when he observed at the right moment and in the right place the mechanism of a wine press that gives him the idea of the printing press.

Contextual Environment

It is necessary to avoid a romantic mystification of the isolated creative genius and the illusion of the figure of the serendipitist who was capable of spontaneously generating a stroke of genius fallen from the sky, like the famous apple falling on Newton's head. Discoveries by serendipity are not the products of a simple and sudden "eureka," spontaneously out of nothing, as an ex nihilo creation. They are not reduced to individual capacities alone, nor to a pure gift of heaven, but also take shape and meaning in a context more or less favorable to the emergence of serendipity. In the vein of the multivariate approach of creativity, the cognitive and conative factors are certainly at work in any creative process, including that of serendipity, but the contextual dimension also represents a complementary and equally decisive factor. As presented above, serendipity is certainly the combined result of a Process (P), the capacities of a Person (P) more or less involved in a collective and a specific Product (P), it is also at the same time subjected to environmental conditions, an external Press (P) according to the fourth P of the 4Ps' Model of Creativity (Rhodes, 1961).

The contextual variable (Press) covers the material conditions and the institutional, organizational, social, cultural, and cognitive structure in which the person operates the serendipitous discovery. Context then represents a micro- or macroenvironment that is more or less encouraging, permissive, and rewarding for the expression of dispositions favorable to serendipitous discovery. If "chance favors only the prepared minds" as Pasteur said, prepared minds can be more or less motivated and supported in the risk-taking inherent in the process of serendipity.

A research institution, laboratory, or organization should also be prepared for possible serendipitous discovery and if the case is to recognize it as such, accept and value it (Cunha et al., 2010). No institution can decree, plan, or control the random trigger of a serendipity process led by a sagacious researcher or group of researchers, but each institution can set up an eco-system that is culturally favorable to the emergence of serendipity. Organizational flexibility, a delineation of overly hierarchical structures, an openness to change and support for more peripheral and marginal visions and practices, as well as an epistemic vigilance in relation to unexpected discoveries are all provisions likely to favor serendipity, to collect it and welcome it.

This attention and time given to research outside the marked paths is reflected, for example, in a part of the working time left available for free research and development in the institution. In company research and development laboratories such as Shell, DuPont, 3M or Google, free personal research is between 10% and 30% of working time. The time and space available for this so-called clandestine or drawer research is not a guarantee of the success of a serendipitous discovery, but it is at least a signal in its favor, an attempt to institutionalize a process which is inherently unpredictable.

Transdisciplinarity: An Invitation to Indiscipline?

Discoveries, inventions, and innovations made through serendipity range from physics, chemistry, medicine, pharmacy, astronomy to geography, archeology, law, literature, music, painting, industrial production, sports, food products, or everyday life. Without

making a tedious inventory here, it is simply mind-boggling. Research indicates the concept is used in many disciplines in both the hard sciences and the humanities and social sciences. It is found among others in physics, chemistry, cognitive science but also in history, sociology, philosophy, epistemology, psychology, or in economics and management.

Serendipity is also reflected in new technologies of information and communication. The invention of the hypertext network of the World Wide Web is itself considered a case of serendipity (Van Andel and Bourcier, 2009). It seems obvious that the apparently free and hazardous circulation by navigation in an immense hypertext network of information evokes the basic principle of serendipity. Keyword searches on a search engine can certainly lead to the information or document sought, but they can also come up with unexpected results likely to arouse the curiosity and interest of the user. This 2.0 serendipity (Paveau, 2011) is exercised in the derivation through nodes links on the web and in relational social networks. These exploratory practices open to unexpected informational or relational discoveries on Google or Facebook which are programmed by powerful search algorithms. Under the guise of so-called unexpected discoveries, it is often mainstream elements that stand out, far from the authentic random emergence characteristic of serendipity.

The transdisciplinary ramifications of the concept of serendipity have thus been connected to the new technological possibilities of the Web. Through disciplinary fields, serendipitist researchers and practitioners behave—beyond their similarities and differences—as detectives (Eco, 1992) who, when faced with surprising and seemingly unrelated facts, try to confer an innovative intelligence by assembling them into a new coherent sequence.

Serendipitists of all disciplines use the reasoning by abduction. In addition to deduction and induction, abduction calls for more intuitive and exploratory reasoning, which provides the best possible explanation of a surprising and unexpected fact (Peirce, 1965). Induction and deduction are more conventional types of reasoning based on linear causality between a starting point and a point of arrival: from empirical observations to theoretical generalizations for induction and, conversely, for deduction from theoretical hypotheses toward their demonstration by empirical verification. In serendipity cases, the logical connection between facts and assumptions is more distant, unpredictable, and unexpected. An anomaly, accident, clumsiness, or any other unforeseen event engages an abductive reasoning on new possibilities and not strictly on what must necessarily be. The abduction (or retroduction) allows the creative and heuristic elaboration of new ideas, inventions, and innovations by managing to link facts or unlikely clues to plausible hypotheses.

Serendipitists, open to the unexpected and complex, implement not only nonlinear and nonprogrammed types of reasoning, but they seem to share a taste for interdisciplinarity (Darbellay et al., 2014) and indeed indiscipline (Catellin and Laurent Loty, 2013). The process of serendipity frees itself from the dictate of a preestablished method or protocol; it claims indiscipline in the freedom to think, to seek, and to find. Disruption or even the setting in crisis of disciplinary and conformist thought makes the detection of the unexpected possible (Darbellay, 2015). This act of epistemic disobedience that makes invention and innovation possible poses a new relationship with error or failure. These are no longer perceived/conceived as anxiogenic impasses or obstacles to be avoided at all costs, but on the contrary as opportunities to make new and happy discoveries. By giving a place to improvisation, serendipity offers the opportunity to dive “In the depths of the Unknown to find new!”, echoing the verse that concludes *Le voyage* (1859), the poem by Charles Baudelaire (1821–67).

Conclusion

The concept of serendipity which has its roots in literary history, history, sociology, and philosophy of science has been glamorized in the media. This success around a concept with a fascinating sound evokes a certain paradox. This paradox is the result of a tension between the recognized benefits of serendipity in major scientific discoveries and the functioning of research structures still highly disciplined and giving a massive weight to the organization and planning of research activities in which chance has very little space. Beyond the historical and prototypical serendipity cases described in scientific literature, the current and future possibility of new major serendipity cases probably implies an awareness in research institutions of the limits of the disciplinary model, and the place that can and must still be made to allow creative freedom for unexpected discoveries made through happy chance.

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Social Creativity

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Glossary

Dispositional Factors These are internal causal influences, such as how personality or cognitive process affect a person's creativity.

Distributed Creativity An approach to research that focuses not on what is inside individuals but what happens between them.

Idealism A philosophical position that holds the primacy of thought and mind over the material world.

Innovation The process whereby an idea is developed, articulated, and implemented in a particular field, or through the creation and bringing to market of a product.

Integrative Transdisciplinarity A self-reflective, inquiry-based form of research that draws on systems and complexity theories to integrate pertinent information that found in multiple disciplines.

Materialism A philosophical position that holds the primacy of material factors over thoughts and ideas.

Methodological Holism An approach to research that takes the whole rather than the part (often the social system rather than the individual) as the unit of analysis.

Methodological Individualism An approach to research that takes the individual as the unit of analysis.

Situational Factors These are external causal influences, such as how an organization affects a person's creativity).

Social Creativity Definition Social creativity is an umbrella term for a number of different approaches to creativity that address social factors and issues in the study of creativity. There are considerable differences in the basic philosophical and methodological assumptions of these different approaches. The movement has drawn attention to relational creativity, creativity in relationships and groups, questioned and articulated the roots and philosophical stances of various approaches to creativity. Some researchers have attempted to articulate perspectives that do not view self and society as separate and mutually exclusive.

Unit of Analysis Refers to the most basic entity that is being studied, the who or what of as research project.

Introduction

Social creativity is an umbrella term used to describe a number of different approaches that go beyond psychology's traditional focus on the individual. It initially emerged in an effort to address social factors and issues in the study of creativity. The increased interest in social creativity has drawn attention to such topics as relational creativity, creativity in relationships and groups, the role of the environment in fostering or inhibiting creativity and has also questioned and articulated the roots and philosophical stances of various approaches to creativity. The psychology of women, discussed below, offers a useful entry point into the relevance of social creativity, since it is not possible to fully understand the creativity of women without an awareness of the historical social and psychological obstacles they have faced in participating in activities which receive high recognition, such as the arts and the sciences.

The study of social creativity has also opened up a considerable philosophical discussion, not least because the study of social creativity is not limited to the discipline of psychology, where traditionally most creativity research has been conducted. As a result, there are considerable differences in the basic philosophical and methodological assumptions of these different approaches. This in turn has led to a reflection on how understanding of creativity and creativity research themselves are created. Social creativity researchers have not shied away from tackling issues with a long philosophical history, and an important contribution of social creativity has been to lead researchers in multiple disciplines to reflect on how researchers have created creativity, what the underlying assumptions of every approach are, and how they in turn reflect the researcher's values, positionality, and cultural context.

Overview

The 1980s saw an expansion in the discourse of creativity to include a more “social” dimension. Until that time, creativity research had almost entirely been the province of psychologists and focused on individual persons and dispositional factors, such as personality. Starting with Simonton’s historiometric research in the mid 1970s and then into the 1980’s with Amabile’s social psychological approach, Csikszentmihalyi’s systems theory, and Harrington’s ecology of creativity, researchers began to include the world beyond the individual, exploring situational factors such as the culture of organizations and the role of gatekeepers in the arts and sciences.

The 1990s saw the publication of an increasing number of works addressing the implications of the social turn in creativity research. In 1995 Kasof applied attribution theory to creativity. The fundamental attribution error in social psychology involves making the characteristics of an individual, or dispositional factors, central in interpreting behavior and events. This happens at the expense of situational factors, or what is happening in the world rather than inside the individual. Attribution theory seeks to understand why people behave in a particular fashion. In the case of creativity, it stressed the role of situational factors and in particular social judgment. Kasof wrote his article at a time when Csikszentmihalyi’s systems model, which emphasized the role of “gatekeepers” in assessing who is and who is not creative, was gaining in popularity. As a result, social creativity began to be viewed as a movement predominantly concerned with the role of social judgment. This in turn created considerable controversy, not least because psychologists were concerned there would be a shift in the emphasis of creativity research to situational and sociological factors that psychologists considered inessential.

Also in 1995, Montuori and Purser critiqued what they saw as the dominant “lone genius” view of creativity in popular culture as well as its traces in academia, and made an argument for a more contextual and relational view of creativity (Montuori and Purser, 1995). Drawing on systems theory they emphasized the interplay between dispositional and situational factors, a view that had its roots in Morris Stein’s transactional creativity and Frank Barron’s ecological view (Barron, 1972; Stein, 1963). Montuori and Purser emphasized the need to uncover the philosophical, methodological, and cultural assumptions of creativity research, as it had become clear that creativity was being framed and understood differently depending on theoretical frameworks and disciplines. They also pointed to several important areas that had not been sufficiently researched, such as creative relationships, creative groups, environments that support creativity, and the creativity of women, and argued for the integration of multiple disciplinary, philosophical, and methodological perspectives in the study of creativity.

A few years later, their two-volume edited *Social Creativity* included essays by leading creativity researchers as well as philosophers, anthropologists, management theorists, and systems theorists (Montuori and Purser, 1999). There were several notable essays in that volume. Frank Barron, an early pioneer of creativity research, argued that the dominant view of creativity was a reflection of the monotheistic image of God and the seven days of creation. Barron argued that the image God the Father should be joined by the Mother, reflecting the view that *All Creation is Collaboration*, the title of his chapter (Barron, 1999). Barron saw the shift from individual creation to pro-creation or co-creation, as quite cosmic and mythical. For Barron, a shift in how creativity is understood and expressed also paralleled a shift in understanding of what it means to be human.

Mark Runco critiqued the trend in social creativity research that emphasized social judgment and “unambiguous” creators (Runco, 1999). He felt that it would draw attention away from creative potential of young people and the not-yet or never-will-be unambiguous and focus too much on what in his view is not directly relevant to understanding creativity. Along with potential, what were later to be called “everyday creativity” and “personal creativity” are not unambiguous creative achievements and may not receive significant social judgment. For Runco, *Creativity Need Not Be Social*, and social judgment is not an essential dimension of creativity.

Dean Keith Simonton compared psychology’s focus on individual genius with sociology and anthropology’s focus on the *Zeitgeist* (Simonton, 1999). He drew attention to this lesser known, sociological and anthropological research tradition in the discourse of creativity, highlighted the fundamental underlying assumptions about the unit of analysis in the different disciplines, and outlined some of the political, economic, and other factors that contribute to a creative society. It’s not just standing on the shoulders of giants, he wrote, but also rubbing shoulders with other creators, surely as good a case as any for social creativity. Volume 2 of *Social Creativity* focused on contributions in management and organization theory, disciplines which were soon to become major contributors to social creativity research and because of their focus on innovation, which is concerned with the larger process of bringing a creative idea to fruition in the marketplace.

The 21st century has seen the blossoming of the sociocultural perspective, spearheaded by the work of Vlad Glăveanu. Glăveanu developed the concept of “distributed creativity” and articulated three main paradigms in creativity research, the He, I, and We paradigms (Glăveanu, 2010, 2014). Glăveanu coined the term distributed creativity to describe creativity that did not reside inside individuals but between them, in their relationships and interactions. The He paradigm studied the traditional “lone genius,” the I paradigm individual creativity, and the We paradigm moved into the broad area of social creativity, predominantly through systems theory and the socio-cultural approach. From the socio-cultural perspective, the first explorations of social creativity still focused primarily on the individual and did not address the full potential and complexity of social creativity. Individual and social creativity were still treated as two separate worlds. A socio-cultural perspective addresses the complexity of the individual-society nexus and a more relational, contextual creativity. Writing in the introduction to the *Palgrave Handbook of Creativity and Culture Research*, Glăveanu (2016) wrote that, “culture is not an isolated factor that can be easily grouped under the general label of ‘environment’ but a *condition of possibility* for creativity” (p. 3). In other words, creativity without culture is simply not possible, and individual and culture cannot be thought of as separate. The individual is in the culture, and the culture is in the individual.

A manifesto co-authored by 20 researchers to be published in the *Journal of Creative Behavior* summarized the central assumptions of the socio-cultural approach (Glăveanu et al., In Press). A manifesto co-authored by 20 researchers and published in the *Journal of Creative Behavior* in 2019 summarized the central assumptions of the socio-cultural approach (Glăveanu et al., 2019). They include but are not limited to the view that creativity is a multidimensional phenomenon, at once psychological, social, and material (physical and embodied), and it involves culturally mediated action. Creative action is at all times relational. Creativity research needs to consider power dynamics both within its analyses and as a field of study. Central to this approach is a critique of the traditional view of the individual and the social as two distinct and separable units. Izabela Lebeda and Glăveanu (2019) Glăveanu and Izabela Lebeda (2019), are the co-editors of the *Handbook of Social Creativity Research*, a volume that brings together the state of the art in this rapidly expanding field, and reflects the growing interest that in social creativity over the last 20 years.

Harking back to Runco's original concerns, the emergence of social creativity and the We-paradigm has led some psychologists to argue for a more focused approach, one that is parsimonious and addresses what they feel is strictly necessary for creativity, its *sine qua non*, which they refer to as the "mechanism" of creativity. This would eliminate bringing in topics that in their view are not directly relevant like social judgment or personality. This approach also brings creativity research squarely back into the psychologists' fold, rather than having it fragmented in a multiplicity of disciplines. An alternative proposal views transdisciplinarity as a way to integrate the voluminous creativity research currently being generated in multiple disciplines, not primarily for the purpose of creating grand theories, although that is not excluded, but for application to specific issues, connecting theory and practice, and bringing the research to bear on a world in need of creative approaches to vexing problems (Montuori, 2018).

Historical and Intellectual Context

The concept of creativity as it is known in the West today can be traced back to the Renaissance, coinciding with the birth of humanism and individualism. It blossomed with the *genius myth* that emerged with Romanticism in the late 18th century. Assumptions about creativity established during the Renaissance, Romanticism, and the Industrial Revolution, continued to shape the cultural imaginary and the academic study of the phenomenon. Until the 1980s, research on creativity in the West was situated mostly in the discipline of psychology and focused primarily on what were known as the four Ps: person, process, product and press). The unit of analysis was almost exclusively the exceptional or "eminent" individual. The romantic mythology created an "atomistic" view, which holds that even complex social phenomena can be traced back to the primacy of the individual, and the social and society are merely an accumulation of individuals. A lasting legacy of this view was that the creative person was mostly a lone, often eccentric, genius, and always white and male.

In the dominant four P's model, the *who* of creativity was a *person*, and was therefore by definition limited to an individual. Groups, organizations, cultures, and relationships were not included, and in fact popularly depicted as representatives of conformity and compliance, and mostly viewed as potential obstacles for the creative person. The genius or more generally the creative person was viewed as being in an oppositional relationship with other people and more generally with society. The social was pitted against the individual. This view is characterized in the popular imagination by such works as novelist Ayn Rand's popular book *The Fountainhead*, also made into a movie in 1949 starring Gary Cooper, which depicted the struggles of a headstrong creative architect unwilling to compromise in the face of an onslaught of demands for conformity and mediocrity. Popular movies about highly creative individuals, such as *Bird*, *Amadeus*, and *Immortal Beloved*, focused on misunderstood, tragic genius figures (Charlie Parker, Mozart, and Beethoven) struggling with an often hostile social environment. These images reflected and in turn fed into the mythology of the genius battling with recalcitrant, conformist, jealous, and often cruel others, as in the highly fictionalized relationship between Mozart and Salieri in *Amadeus*. Another view is that creativity is a "gift" the genius possesses and so it does not require any work, which in the case of Parker, for instance, glaringly omitted the less photogenic years he claimed to have practiced 8–10 hours a day.

A number of intellectual and social developments in the late 20th and early 21st century have questioned the foundations of Western thought. They directly or indirectly led to questioning, critiquing, and proposing alternatives to the dominant individual-centered approach to creativity.

- Psychologists with a social constructionist orientation as well as sociologists have argued that who or what we call "creative" is the result of a social judgment, and that creativity is therefore socially constructed and does not exist "naturally," independently of that judgment.
- Authors in the movement loosely known as postmodernism have critiqued the notion of the autonomous individual. They proclaimed the death of the "subject" and the "author," and ushered in "the birth of the reader." This involves foregrounding readers' individual interpretations and rejecting the dominant role of the author. They also stressed the commercial and political interests and power dynamics embedded in the discourse of creativity. Postmodern thinkers criticized the image of the genius, and the notion of originality, discussing the role of "bricolage," the combining and recombining of existing materials, summarized in the expression "everything is a remix."
- From the perspective of systems and complexity theories creativity research has viewed individuals as closed systems, unaffected by their context. An open system approach situates individuals in their social context and in a network of

relationships. The self-organization and emergence of natural and social phenomena attracted attention, as did the role of “swarms,” with a bottom-up, distributed, rather than top-down approach, stressing the significance of recursive, mutually causal interactions.

- Researchers studying the psychology and creativity of women have argued that the creativity of women cannot be assessed without taking into account social and cultural factors. Women were portrayed as fundamentally not creative in the same way as men are, and through much of history women were not allowed to participate in those very domains in which one would be recognized as creative.
- Cultural psychology is an interdisciplinary field that draws on a wide variety of disciplines including anthropology, neuroscience, cultural studies, and the philosophy of mind. For cultural psychology, mind and culture are not only inseparable but mutually constitutive. Minds shape culture and culture shapes minds, and the emphasis is on studying the nature of this process.
- Management and organization theorists have developed an interest in creativity as part of the larger process of innovation. Whereas the creative process has traditionally been viewed as something that goes on inside an individual and leads to the proverbial lightbulb going on, the process of innovation includes idea generation but is much more extended in time and space. Idea generation is important, but part of larger process that goes all the way to implementation and is therefore by its very nature a more social process.

These are but some of the intellectual trends and developments that have contributed to research in social creativity. It should be pointed out that the focus on the individual creator and the genius has also, ironically, become a marketing tool that reflects the deeply interwoven nature of individual and society. The relatively recent focus on social creativity also parallels the fact that post baby-boom generations seem to be less interested in genius, and more in everyday and relational creativity.

Women and Creativity

The history of women and creativity provides an important entry point into the relevance of social creativity. Historically much if not most creativity research has been about eminent white males in the West. As a result, the picture that was first developed about creativity, the creative person, and the creative process, is based on a sample that was almost exclusively white and male. Eysenck (Eysenck, 1995) summarized the effect of this sample with the following conclusion: “Creativity, particularly at the highest level, is closely related to gender; almost without exception, genius is found only in males (for whatever reason!)” (p. 127).

It is perhaps not surprising that Eysenck should conclude with “for whatever reason.” While in 1995 there was already considerable research on the historical struggles of women in the arts and the sciences, the topic was only beginning to attract interest in psychology. Given the fundamental attribution error, it might be tempting to seek the reason for women’s under-representation in the lists of great creators to their personalities or cognitive processes or even genetics. Feminist scholars have argued for years that for most of recorded history women were not given full access to the domains in which creativity could be demonstrated (the arts and the sciences). In Europe and the USA women were not allowed to practice drawing nudes, give concerts in public, go to medical school, and study science until the middle of the 19th century. These social factors clearly inhibited the creative potential of women, and the perspective of historians and sociologists contributes to a broader picture, addressing aspects of women’s lives that psychologists generally do not address. The argument has also been made that the discourse of genius and creativity is shaped by male-centered or even patriarchal approaches which started out with the assumption that, broadly speaking, men are creative and women make babies.

But does the fact that women had no access to socially recognized domains of creativity (major artworks, scientific breakthroughs, etc.) mean that they had no opportunity to be creative in Europe and the USA until the 20th century and therefore were simply not creative for millennia? Or merely that working within the social limitations, the definition of the what, who, where, and how of creativity was preventing an understanding how the creativity of women was manifesting? Is it the case that, despite their lack of access to traditionally accepted domains of creativity, women are simply not as creative as men? This does not appear to be the case.

Perhaps it is necessary to redefine creativity through an articulation of a more relational perspective and highlight the many ways in which women have been creative in different contexts and different ways (Eisler et al., 2016). Examples include areas that have traditionally been seen as women’s domains, in the home, child-rearing, and in such private, domestic activities as improvising meals for the family rather than in more public, dramatic ways such as becoming celebrated chefs. The creativity of women, while initially excluded from the arts and sciences, has therefore historically manifested in what today might be considered more social, more relational, and more *everyday* activities, as opposed to socially recognized creativity. In that sense, the new interest in *everyday, everyone, everywhere* creativity is prefigured in the creativity of women, meaning more specifically the areas in which women could express their creativity. This should not be interpreted to mean that these are the only areas where women can or should be creative, of course, simply that given the social restrictions, articulated so well in Virginia Woolf’s *A Room of One’s Own*, women were in fact being creative during the centuries they could not participate in the domains where eminent creativity was recognized, but in domains and ways that were not as yet recognized in the research literature or socially acknowledged.

Ravenna Helson (1990) wrote that

We think the understanding of creativity in women requires attention to the social world, to individual differences in motivation and early object relations, and to changes in society and the individual over time. In fact, we believe that the study of creativity in general needs all of these directions of attention (p. 57).

The reasons for Helson's argument for a more social approach are clear and not just confined to an understanding of historical obstacles. In the last 50 years considerable changes have seen many more women become prominent in the arts and the sciences and join the rank of Nobel prize winners. Nevertheless, in the early 21st century, research found that girls and boys are taught science differently, it is still difficult for women to break into certain disciplines, and Silicon Valley, a center of tremendous innovation, is criticized for being a "brotopia" that excludes women. What Helson is pointing to is the need for an approach that draws on multiple disciplines and recognizes the pervasive role of culture in shaping young women, their choices and opportunities, as well as the way the cultures of organizations and universities can exclude women. Along with understanding how women have been excluded from creative endeavors, it is also important to explore how a better understanding of women's creativity might broaden our understanding of creativity as a whole. Social creativity is beginning the exploration of a more relational approach to creativity.

Philosophical and Disciplinary Considerations

The emergence of social creativity brought focused attention to the way in which researchers create their understanding of and approach to creativity. As a result it has raised numerous complex and important issues that can be traced to ongoing debates in philosophy and specifically the philosophy of social science, as well as the role of disciplines in framing questions and entire subject areas.

The interest in social creativity has shown how different disciplinary perspectives and different underlying philosophical and cultural assumptions can lead to very different perspectives on creativity. In the philosophy of social science, the different perspectives broadly underlying psychology and sociology are sometimes referred to as atomism and holism, or more specifically methodological individualism and methodological holism respectively. If atomists argue for the primacy of the part and the fictitious nature of the whole, as in Mrs Thatcher's famous statement that there is no such thing as society, holists argue for the primacy of the whole over the part. A key difference between psychology and sociology is precisely the choice they make about whether to foreground the part or the whole. This choice determines the *unit of analysis*. Psychologists have historically viewed creativity as the result of dispositional characteristics, processes, and properties of individuals. For the vast majority of psychologists, the individual is therefore the unit of analysis. Sociologists and anthropologists have viewed creativity more as a function of social structures and processes, and the *Zeitgeist* or spirit of the times, therefore situationally.

For methodological individualists in creativity research, the focus on the individual also means that whatever is outside the individual is essentially *epiphenomenal*, or not causally affecting the phenomenon in question. In this view it is not necessary to include factors that are considered epiphenomenal in order to gain a full understanding of creativity, and it has been argued that any attempt to include complex factors such as culture would simply be too daunting. The implications have been considerable, and not limited to making the research process more manageable. With methodological individualism the dominant approach in American creativity research, it is not surprising that creative collaborations, group creativity, the study of creative cities and epochs and generally of environments that foster or hinder creativity have historically received less attention, with some notable exceptions.

For methodological holists it is individuals who are epiphenomenal. Specific individuals are merely vehicles for ideas that are part of the *Zeitgeist*, or ideas that are "in the air." This is not a mystical phenomenon but usually simply the result of an accumulation of developments in a particular field leading to a situation where it is almost inevitable that someone will take the next logical step. The phenomenon of "multiples," when two or more scientists come up with the same idea—Darwin and Wallace with evolution, for instance—is often used as an example. The role of networks connecting schools of thought and tracing lineages of philosophers and social scientists, has also begun to play a role in the understanding of creativity in the history of ideas.

The underlying philosophical assumptions of the two major perspectives on creativity have further differences. Using rather broad generalizations, it has been argued that the psychological, individualistic approach is also fundamentally *idealistic* in the sense that it focuses largely on the generation of creative ideas, but no systematic attention is paid to how those ideas can become a reality. Idealist philosophy is more interested in the idea rather than its physical manifestation. An idealist aesthetics holds that the score of a musical composition is an ideal which can only be approximated by a performance because it is closer to what the composer had in mind, and subject to less translation and interpretation. This is arguably the view of psychologists who want to decouple creativity from the social, by eliminating the term "useful" from the definition. What is essential for them is the generation of creative ideas, and specifically the mechanism whereby ideas are generated. They are less or not interested at all in the implementation.

Sociologists, and particularly sociologists of work, have brought a different perspective to the table, namely a more *materialist* philosophy. This is evident in their close study of what it actually means to work in professions such as the arts and put on a jazz performance, get a motion picture into the theaters, a novel into bookstores, and so on. The sociologist Howard Becker listed the credits of a motion picture to give an idea of the enormous collective effort that is required to bring a movie in front of the public. The same is true for a musical recording, getting a book from the author's desk to the bookstore, and even a school production of a musical. To attribute the creation of a motion picture, the performance of a jazz group, or the design of a fashion item to

one individual simply overestimates the importance of the individual and does not recognize the contribution of others. The romantic mythology of the creator as lone genius takes a back seat to the network of relationships necessary to take any creative idea into the world.

Key differences between the two approaches are in the definition and scope of the creative process. Can the creative process be reduced to the essential moment the light-bulb goes on, or is it a process that can be traced beyond the individual, perhaps as far back as the education and preparation preceding the idea(s), and then all the way to implementation, bringing a product to market or a concert performance of a composition? The sociological approach has broadened the understanding of creativity to the extent that it tells us about how an idea becomes a reality, and clearly this is an extremely important dimension of the process. A greater understanding of the process by which creative ideas become realities can also help create environments and systems that facilitate creativity. Where we draw the boundary around what constitutes the creative process is a function of the researcher's disciplinary and philosophical perspective. Systems theorists refer to this as the system definition, essentially what is in and what is out of the scope of any inquiry. One view sees the creative process as confined to the generation of the idea, for the other it extend to include the entire production of a movie, including the script writing, editing, and all the support functions from the technical to the logistical. This difference exemplifies the different definitions of creativity and innovation, idealist and materialist respectively, but it also reflects different angles on a large and complex phenomenon, each offering insights that reflect a different facet.

Are these contrasting views of the who and how of creativity opposed, incompatible, or complementary? Or would the relationship best be described by saying ... it's complicated? The history of social science is full of oppositions and polarizations, with schools of thought and disciplines identifying themselves in opposition to each other. The disciplinary split between psychology and sociology is one example, showing up as the lone genius versus the zeitgeist, but also individual agency versus sociological determinism.

The problem of disciplinary fragmentation means that researchers in one discipline may be carrying on their own research agenda with assumptions and theoretical frameworks that are diametrically opposed to those in the discipline next door, which might as well be a universe next door, often blissfully unaware of what their neighbors are doing. If each discipline or subdiscipline believes it has the right (and most legitimate or scientific) approach to creativity, then researchers may choose to ignore each other or argue against other perspectives. While debate and critique are healthy, it is a sad fact that exchanges among academics are often critical rather than creative, as captured in statements like "I defended my position," "she destroyed his argument." Arguments over intellectual territory are not unusual but attempts to create across disciplines can be few and far between.

How to address this often conflicting proliferation of research, disciplines, and assumptions? Most academics do not receive training in integrating knowledge across disciplines, or in how to be socially creative in the study of creativity. A key challenge for creativity researchers today, during a historical moment when creativity is needed more than ever, is to connect across disciplines and across cultures to put creativity research to work. While increasing specialization is a given for academia, social creativity points to the need to be able to integrate complex ideas and pertinent findings across different disciplines and each with different fundamental assumptions, a task which itself requires social creativity. In that sense, the criticism that social creativity is too complex, and researchers would be better off working with clearly delineated closed systems that are all within their specific area of competence is perhaps legitimate, given the current state of affairs. But one of the most exciting aspects of social creativity research is precisely that, by its very demands, it may usher in a new and more complex, transdisciplinary approach to creativity.

Conclusion

The broad umbrella of social creativity has drawn attention to and created a space for research in topics such as creative relationships and groups that had largely been ignored until the 1990s. It has also led to philosophical questions and debates about the nature of the individual, the relationship between individual and society, and the nature of creativity. Social creativity has also begun to explore how creativity research itself has been created, through the way it is represented in popular culture, with implicit folk beliefs about creativity, and by creativity researchers themselves, who are themselves not immune to the influences of their own culture. Increasingly, researchers are approaching creativity from a multiplicity of disciplines and perspectives. Understanding social creativity requires this rich multiplicity of views and thereby makes new demands of researchers to expand their scope and become inter- or even transdisciplinary. Social creativity may succeed in articulating the centrality of creativity in society and social change processes, thereby bringing creativity to the forefront of social research.

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Social Innovation

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Glossary

Causal analysis Identification of the causes operating in complex systems.

Constraint analysis Identification of conditions that bound, or limit, solutions.

Creative thinking skills Processing activities by which people work with knowledge to produce new ideas or problem solutions.

Forecasting Projecting the downstream implications of actions.

Institutions Social systems characterized by people, norms, and expectations.

Planning Envisioning actions needed to accomplish a task.

Social innovation Creative solutions to social problems.

Wisdom Appraisal of the value of actions in a social context.

Social Innovation

The most common image of a creative person is of an individual working alone, who produces a unique product of exceptional value. Thus, artists are seen as creative. Scientists are seen as creative. Composers are seen as creative. Although this entry does not dispute the creativity required for eminent achievement in the arts and sciences, the argument will be made that the notion that creativity involves only individual production is, in fact, misleading.

Creativity has been defined as the production of original, high-quality, and elegant solutions to complex, novel, ill-defined problems. At times complex, novel, ill-defined problems cannot be solved by a single person working alone. Accordingly, many research studies have examined how teams go about solving creative problems, how creative teams should be led, and how institutions should support creative efforts.

Not only does the social context shape the nature and success of creative work, the social context in which human activities occur also presents many complex, novel, ill-defined, or poorly structured problems—problems that cannot be solved simply through norms or routines. Traditionally, the solutions of complex, novel, ill-defined problems which arise in an institutional, or social, context are the responsibility of leaders. And, in fact, creative thinking is a crucial determinant of leader performance. However, the solution of institutional problems may come from many sources, entrepreneurs, activists, and even politicians, and it is the solution of novel, complex, ill-defined problems arising in an institutional context that defines what is meant by the term social innovation.

Case Studies

Even the most cursory review of history suggests social innovation plays an essential role in human progress. Much of modern life occurs in industrial institutions, business firms, and these firms clearly depend on social innovation. One key basis of the modern firm is the concept of standard operating procedures. It was Frederick Taylor who had the idea of posting standard operating procedures on lathes in a machine shop. Modern industrial institutions also depend on mass production procedures. And, as Mumford and Moertl (2003) noted, mass production ultimately was based on an innovative solution to a distinctly social problem—a solution which initiated a chain of other social and technical innovations.

Social innovation is often critical in politics. One example may be found in Lyndon Johnson's establishment of the Equal Employment Opportunity Commission as a way of reducing discrimination in United States firms. Advances in city planning and human housing can be traced to social innovations advocated by Robert Moses and Jane Jacobs. The work of many social advocacy institutions, for example, the United Way, Doctors Without Borders, or Alcoholics Anonymous, all are based on social innovations.

Mumford (2002) conducted a qualitative study of one historically notable social innovator, Benjamin Franklin, in part because he left firsthand accounts of multiple social innovations he developed in a fixed social environment—colonial Philadelphia. These ten historically noteworthy innovations included establishing paper currency, establishing the first nonsectarian university, and creating volunteer fire departments. A review of these cases indicated, first, that social innovation required creative thinking skills as traditionally defined and, second, a complex set of unique skills, tied expressly to social innovation, such as causal analysis, forecasting, and wisdom.

Creative Thinking Skills

Mumford et al. (2012) described what has become the standard model of creative thinking. They argued creative problem solutions require knowledge, or expertise, along with successful execution of a series of eight cognitive processes for transforming extant knowledge into viable, original, high-quality, and elegant problem solutions: (1) problem definition, (2) information gathering, (3) concept/case selection, (4) conceptual combination, (5) idea generation, (6) idea evaluation, (7) implementation planning, and (8) adaptive monitoring. In fact, an examination of the careers of social innovators, Benjamin Franklin and Jane Jacobs, indicates they had acquired substantial expertise with regard to the social problem at hand—Jacobs was an architectural critic; Franklin routinely reported on fires in Philadelphia. The evidence accrued in recent years, moreover, indicates that effective execution of all of these cognitive processing operations are also critical to solving social innovation problems.

Conceptual combination, combination and reorganization of extant knowledge structures, provides the basis for establishing the new knowledge structures that allow people to formulate viable new ideas. Scott et al. (2005) showed that skill in conceptual combination also contributes to performance in solving social innovation problems. In this study, participants were asked to formulate a curriculum plan for a new experimental secondary school, a social institution, where judges appraised solutions for quality, originality, and elegance. Participants were instructed to use various strategies in conceptual combination where concepts, or cases, were presented. It was found effective execution of these conceptual combination strategies resulted in the production of more original, higher quality, and more elegant curriculum plans.

In another study along these lines, Redmond et al. (1993) examined peoples' performance in solving another type of social innovation problem—a marketing problem. Participants' marketing plans were appraised by marketing professionals for quality and originality. Notably, a manipulation was induced to encourage better problem definition. This manipulation asked, or did not ask, participants to write down key issues and concerns and define the problem in their own terms before formulating their marketing campaigns for a new product—the 3D Holographic TV. It was found that those who were exposed to this problem definition manipulation produced solutions of higher originality and greater quality to this social innovation problem.

In another study, Gibson and Mumford (2013) asked participants to formulate a plan for a firm which intended to extend its product line into a new region or new market—a different cultural market. Plans were appraised by judges for quality, originality, and elegance. Notably, idea evaluation was examined by asking participants to criticize candidate campaign ideas before starting work on their own campaigns. Evaluations of these ideas indicated participants who produced a limited number of deep criticisms developed stronger, more original, higher quality, and more elegant, solutions to this social innovation problem.

The foregoing studies indicate conceptual combination, problem definition, and idea evaluation, three key creative thinking processes, influence peoples' ability to produce viable solutions to social innovation problems. When this observation is considered in light of other studies demonstrating that effective execution of other creative thinking processes contributed to the solution of social innovation problems, it seems reasonable to conclude that standard creative thinking skills are, in fact, needed to solve social innovation problems. However, it appears, due to their unique nature, social innovation problems may require a broader array of skills.

Causal Analysis

In institutions, or social systems, the causes of a problem are not evident, and many causes operate. Thus, to solve social innovation problems people must be able to identify critical causes. The impact of causal analysis skill in solving social innovation problems has been examined in a series of studies by Hester et al. (2012) and Marcy and Mumford (2007). In these studies, participants were asked to complete, or not complete, a set of self-paced training modules intended to improve their causal analysis skills: thinking about causes that (1) have large effects, (2) have direct effects, (3) are controllable, (4) can be manipulated, (5) effect multiple outcomes, (6) operate synergistically, and (7) work together.

In the Marcy and Mumford (2007) study, participants were asked to solve six social innovation problems, three drawn from the educational domain and three drawn from the business domain, where judges appraised solutions for originality and quality. In another study, participants were asked to work on a simulation exercise with the objective of improving teaching at a university

where performance was appraised using objective markers of game performance. In a study by [Hester et al. \(2012\)](#), participants were asked to formulate a marketing campaign for a new high-energy root beer where judges appraised solutions for quality, originality, and elegance. These studies indicated that training in causal analysis skills resulted in production of solutions of higher quality, originality, and elegance, better exercise performance, and, additionally, stronger mental models for understanding social innovation problems. Thus, causal analysis skills apparently contributed to social innovation.

Constraint Analysis

Social innovation problems are always constrained by people's vested interests and prior capital investments. Thus, solutions to social innovation problems must be formulated within a set of social constraints ([Medeiros et al., 2014](#)). Indeed, finding ways to work around constraints may be critical to solving social innovation problems. The impact of constraint analysis skills on social innovation was demonstrated in a study by [Peterson et al. \(2013\)](#).

In this study, participants were asked to formulate a curriculum plan for leading a new experimental secondary school. Judges appraised plans for quality, originality, and elegance. Before starting work, participants were asked to illustrate their mental model for understanding secondary school performance and, again, illustrate their mental model after completing all study activities. In between, however, prior to starting work on their solutions to this social innovation problem, participants were asked, or were not asked, to complete a series of four self-paced instructional modules to help them analyze constraints: (1) resources constraints, (2) system capability constraints, (3) user skill constraints, and (4) goal constraints. Findings indicated that this instruction in constraint analysis resulted in higher quality, more original, and more elegant solutions to this social innovation problem as well as acquisition of better mental models for understanding the problem.

Planning

Social innovation problems differ from other problems in that multiple people must be marshalled, or organized, to act on various causes and constraints. This rather straightforward observation implies planning skills will also be required to solve social innovation problems. Some rather compelling support for this proposition was provided in a study by [Marta et al. \(2005\)](#). In this study, 55 teams were asked to formulate a "turn around" plan for a failing automotive firm where failure was due to a host of socio-technical issues. Judges appraised the quality and originality of the resulting turn around plans. After teams had formulated their plans, they were asked to nominate their leader. And, all participants, regardless of leadership role, were asked to complete a measure of planning skills.

The planning skills measure presented a series of institutional planning scenarios where participants were asked to select responses marking differing levels of various planning skills. The highest quality and most original "turn around" plans were produced by teams whose leaders evidenced strong planning skills. Other studies showed that training people in key planning skills, by providing appropriate planning strategies, resulted in production of higher quality and more original solutions to social innovation problems.

Forecasting

Plans sometimes work out and sometimes do not. Forecasting the outcomes of a plan execution allows people to anticipate the downstream implications and provides a basis for revision of the plan if needed. In fact, viable forecasts may allow people to formulate actions to address the kind of roadblocks that emerge in many social innovation efforts. Although it seems reasonable to conclude forecasting is critical to social innovation, peoples' ability to forecast effectively has been questioned.

In a study, participants were asked to assume the role of a member of a funding agency's proposal review board. They were asked to review three educational proposals or three public policy proposals—all social innovation problems. Both the education and public policy proposals had actually been executed, so resource requirements and outcomes were known. As a member of this review panel, participants were asked to estimate, or forecast, resource requirements and outcomes. It was found these forecasts could be quite accurate, within a fifth of a standard deviation, at least when participants had expertise and believed their recommendations would be acted upon ([Dailey and Mumford, 2006](#)).

If people can forecast accurately, the next question is whether forecasting contributes to performance in solving social innovation problems. A study asked participants to formulate a marketing campaign for a high-energy root beer ([Byrne et al., 2010](#)), while in a related study, participants were asked to formulate a curriculum plan for leading a new experimental secondary school ([Shipman et al., 2010](#)). The marketing and school plans were appraised by judges for quality, originality, and elegance.

As participants worked on each of these low-fidelity simulation tasks, prior to plan production, they received a series of emails, from consulting firms or their managers, where they were asked to forecast the implications of executing their ideas. Judges appraised these written forecasts and four general dimensions emerged: (1) forecasting extensiveness, (2) forecasting time frame, (3) forecasting resources, and (4) forecasting negative outcomes. More centrally, it was found that the extensiveness of forecasting and forecasting a longer time frame were strongly ($R \approx 0.40$) positively related to the production of higher quality, more original,

and more elegant solutions to both social innovation problems. Indeed, the prediction of performance vis-à-vis forecasting was, in fact, stronger than traditional ability measures such as intelligence and divergent thinking. Thus, forecasting, especially extensive forecasting, considering multiple alternative scenarios, seems critical to peoples' success in solving social innovation problems.

Wisdom

Extensive forecasting will lead to the production of multiple, varied, outcomes as a result of planned actions. These forecasts will have different impacts on different stakeholders. Thus, in social innovation, people must be able to appraise how their anticipated actions will affect various stakeholders. Put differently, viable solutions to social innovation problems require wisdom. In fact, it has been argued that wisdom is a critical skill for solving many types of creative problems, especially social innovation problems.

Some rather compelling support was provided in a study by [Connelly et al. \(2000\)](#). A sizable sample of Army officers, some 1800, ranging in grade from Second Lieutenant to full Colonel, were asked to describe their performance in addressing critical incidents encountered over the course of their career—incidents appraised by judges for performance effectiveness. In addition, they were asked to solve a social innovation problem dealing with reorganization of the Army into a regimental structure. These officers were also presented with a series of complex ambiguous problem scenarios describing events in the life of middle managers. Officers were asked to provide written answers to three questions: (1) Why did this situation occur? (2) What was the mistake made in this situation? and (3) What would you do if you were in this situation?

Trained judges with expertise in psychology appraised written answers to these questions for dimensions held to underlie wisdom such as systems perception, objectivity, sensitivity to solution fit, judgment under uncertainty, self-reflection, and systems commitment. When performance on the social innovation problem and critical incident performance were correlated with, and regressed on, these attributes of wisdom multiple correlations in the 0.40 s were obtained for both the social innovation problem and critical incident performance. Thus, wisdom contributes to performance, “real-world” performance, perhaps because it is a critical skill which allows military officers, to solve the social innovation problems institutions expect them to address.

Conclusions

This entry reviewed studies which are noteworthy because they suggest wisdom, forecasting, planning, constraint analysis, and causal analysis all contribute to peoples' ability to solve social innovation problems. These abilities work along with traditional creative thinking skills (conceptual combination, problem definition, and idea evaluation) traditionally held to contribute to creative problem-solving across a number of domains. Thus, solving social innovation problems may be a particularly complex activity requiring both creative thinking skills and special skills uniquely related to solving social innovation problems. Although solving social innovation problems represents an especially complex activity, it should also be recognized that many studies of social innovation, for example [Marcy and Mumford \(2007\)](#), indicated that these skills, causal analysis, constraints analysis, and wisdom, can be developed. Given the complex nature of social institutions, and the real-world value of solving the social innovation problems presented by these institutions, there would seem to be ample justification for systematic interventions intended to develop these social innovation skills.

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Social Transformation

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Introduction

Change is urgently needed in human society. Longstanding problems such as hunger, poverty, and armed conflict resist even the best efforts to solve them. Industrial capitalism (with its focus on producing more and more objects of consumption) has been taken beyond survivable limits. Tribalism, racism, and misogyny have increased, with the help of modern technologies. Fortunately, visionaries with imagination and resourcefulness are working in transformative new ways to tackle these problems.

- Rats are trained to detect buried explosive mines in former war zones and to indicate their location to their handlers; human teams then more safely clear the mines.
- Homeless people are taught beekeeping skills, which simultaneously addresses homelessness and the falling numbers of our most important pollinators.
- Temporary “popup” repair shops offer free or low-cost repairs of household objects and appliances, keeping them out of landfills and reducing the use of resources to make and market new ones.

According to Bulut et al. (2013), *social innovation* is a relatively new term. For this article, we will use Phills, Deiglmeier, and Miller’s definition (quoted in Bulut et al., 2013, p. 437): “Social innovation refers to a novel solution to a social problem that is more effective, efficient, sustainable, or just than actual solutions, and for which the value created accrues primarily to society as a whole rather than private individuals.”

Of course, it is possible for social change to move toward violence, greed, and prejudice. Social media, for instance, in addition to encouraging justice and building useful networks, have stoked hatred and spread falsehoods, divisiveness, and violence. This article, however, focuses on positive innovations that support ecosystems, justice, health, and equality of opportunity. In recent decades, new services and tools have been invented to help people collaborate, even at a distance.

- Pooling funds from hundreds of people to “kickstart” a worthy project, bypassing traditional funding gatekeepers.
- Citizen science, when amateur enthusiasts contribute to genuine research,
- Community Supported Agriculture, which links farmers directly to their customers.

Meanwhile, in some cases individuals have invented solutions with minimal outside support.

- Shoes designed to enlarge along with the growing child, reducing child-rearing costs for the poor.
- Planting live trees to make corrals to protect cattle from marauding lions (and lions from irate herders),
- A functional bicycle made out of cardboard.

Some of these innovations have received academic evaluations, which are noted here. By the nature of this topic – recent inventions – some have not. Perhaps not all of these inventions (and others described below) will stand the test of time, but the sheer

profusion of resourceful ideas offers evidence that people of all ages, nations, races, and classes are facing our problems with ingenuity and hope.

Definitions

Creativity in this context means innovation with an explicit goal to solve a real-world problem, such as hunger, war, disease, extinctions, and environmental destruction. Creativity is difficult to define according to some authorities (Acar et al., 2017) but not others (Runco and Jaeger, 2012). Commonly studied factors are originality and practical value.

Environmental problems. Human activities (including overpopulation) that overuse or destroy resources, or cause degradation of ecosystems, leading to climate change and (among other things) species extinctions beyond the background rate caused by natural processes.

Social change. The purposeful alteration of conditions, processes, laws, and customs. *Social transformation* involves larger changes, deeper insight, questioning of assumptions, originality of solutions, and the expectation that deleterious unintended consequences should be minimized. All stakeholders are, as far as possible, taken into account, and the circular economy (also called cradle-to-cradle; McDonough and Braungart, 2002) eliminates the concept of waste.

Social innovation. A non-physical creation that involves connection, networking, and in some cases the use of technology to address a problem. Examples include distance learning, hospice, restorative justice, congestion charges to modify traffic, open source software, and microcredit (Jiang and Thaggard, 2014).

Social problem. Conditions that cause unnecessary pain, destruction, or waste. "Unnecessary" because some pain is inevitable, such as the death of a loved one. "Waste" because earth's abundance is not unlimited, and we are consuming ourselves out of house and planet. Waste can include waste of people, as through drugs and the prison-industrial complex, and underutilization of people through poor education, biases, or cultural traditions.

Why Creativity Is Needed

Given the severity of the global problems that humans have created, we must act promptly. Familiar strategies for change (strikes, boycotts, education, legislation, court decisions, support groups) are valuable, but insufficient, for several reasons (Riebel, 2015, 2017):

- Usual solutions are *too slow*.
- Many of the problems are *interlinked*.
- Solutions must require *less extraction of natural and human resources*.
- Solutions must *take all people into account*.
- *Psychological defense mechanisms* protect many people from seeing and tackling the problems.
- *Political will* is needed to overcome defense mechanisms, entrenched opposition, vested interests, and inertia.

Creativity Is Already in Use

The range of social-change creativity is impressive. The people involved range from highly educated to barely literate; urban to rural; young to old; first-world to third-world. The domains include agriculture, food waste, endangered species, healthy exercise, packaging, refugees, street children, waterborne illnesses, organ donations, and dozens more. Innovations are being devised by individuals, pairs, small groups, large groups, governments, and corporations. There is serious academic interest in creative social change, as attested by the growing number of departments, courses, degrees, and dissertations.

Creativity has been tied to everything from artistic achievement to entrepreneurship to cultural evolution. It may very well represent one of the most basic and important human capacities, as evidenced by its role in so many and such diverse domains and endeavors.

Runco and Kim (2011, p. 534)

Domains and Applications

By definition, the creative acts described in this article are of practical use, incomplete until they reach production and distribution, helping solve social and environmental problems. This accords well with Simonton's view (quoted in Allen and Thomas, 2011, p. 114) that "creativity requires persuasion and social influence. In other words, a creative act can only be fully creative if it reaches an audience."

The cornucopia of inventions both physical and social in the last few decades demonstrates creative thinking at work. Some of them undo our previous errors of waste and destruction, such as using biodegradable flexible rings to join 6-packs of beverages, thereby reducing threats to wildlife. Some advance primal needs: a large drum made of industrial plastic can be wheeled along the ground, efficiently moving large quantities of water. Some solve several problems at once: offering free housing to university

students who provide companionship and help to elders in nursing homes. Some are quirky: an advocate for bees runs races backwards to draw attention to the serious threats facing these vital pollinators. Some re-envision society: the Soccket captures kinetic energy in soccer balls to provide electricity, harvesting the value of the simplest human motions. Some recapture traditions: A Zuni map project enlists elders, leaders, and artists at the A:shiwi A:wan Museum and Heritage Center in New Mexico to reclaim the Zunis' understanding of land and place. Instead of mathematical coordinates and Anglo or Spanish place names, the maps commissioned by the project display natural features, traditional creation and migration stories, native names, and colorful paintings.

Some inventions are created by developers who are trained professionals in the relevant field and some are developed by amateurs. Some are physical inventions, and some are social innovations, some of which employ technology to link people together efficiently.

High Tech Versus Low Tech

Of the various dimensions that characterize creativity and social change, one of the most significant is the degree of technology required to develop an invention and make it available to end users.

Low tech. Using existing or easily fabricated objects, people have devised solutions to various challenges. In 1970 when an explosion aboard the Apollo 13 spacecraft endangered the lives of the astronauts, a team on the ground had to instantly invent a way to connect two incompatible machines to clear the air of life-threatening levels of carbon dioxide, using objects that they knew were already on board the craft.

They succeeded, and members of the most sophisticated, complex, high-tech mission ever attempted were saved by scissors, duct tape, cardboard torn from a manual, hoses used for emergencies, and plastic tubing from a moonwalk garment.

Advantages of low tech. Aside from such dramatic rescues, in poorer countries without modern infrastructure, power and water can be made available using low-tech devices like the LifeStraw water purifiers and a simple gadget that generates light by harnessing gravity. Such innovations usually involve less waste and require less time to install.

High tech. The tiny house movement is meant to provide shelter for poor and homeless individuals, or for people wanting or needing to live lightly. Often these are relatively basic structures, but a Slovakian company builds high-tech ones (Ecocapsules) for the more affluent, equipped with solar power, wind turbine, rainwater collection, computer monitoring of electricity and water use, and more. The ecocapsule, which is easily moved, could help solve housing shortages that occur even in prosperous societies.

Advantages of high tech. For some applications, basic elements already exist. Cell phones can help remote inland farmers bypass profit-taking middlemen, learn the true value of their goods, and receive fairer compensation. Additionally, cell phones leapfrog over costly 20th-century infrastructure (miles of telephone lines), making the delay and cost of installing the latter unnecessary. In Tasmania, “virtual fences” – small light- and sound-emitting devices installed along roadways – have drastically reduced the number of mammals killed by automobiles.

Domains

Any domain of life has potential for creative individuals to introduce improvements: food, housing, energy, environment, community, animals, waste, health, safety, transportation, and more. Some solutions address multiple domains at once, e.g., food and waste, or energy and environment. Consider conflicts between humans and wildlife, as in the following example of protecting people and animals from each other.

Farmers play “crops and robbers” as they work to protect their harvests from insects, birds, and other hungry wild animals – including the largest ones. Elephants and tigers are among the land mammals most involved in conflict with human farmers, who often kill them. Defenders of wildlife look for solutions, especially multiple approaches that can be used in rotation to prevent animals from habituating to them. Scientists knew that elephants fear and avoid bees, which can sting their sensitive eyes and trunks. In her doctoral dissertation, King played recorded beehive sounds to elephants in Kenya and found the sounds caused the elephants to leave the area and emit unique alarm calls to warn other elephants. After discussions with local farmers, King and her team placed hanging beehives around the crops of African farmers who might otherwise be in dangerous conflict with crop-raiding elephants. Followup studies confirmed the value of this approach (King et al., 2011, 2017, 2018). This team included scientific professionals and highly motivated community members who were knowledgeable about local conditions and behaviors necessary for the project's success.

The next two sections of this entry explore domains that have drawn particular interest from creative social changemakers: food and the arts.

Creativity and Social Transformation: Food

Food, besides keeping us alive, is the focus of culture, tradition, and family life. Currently it is also a focus of innovations that address social and environmental problems. Hunger has been addressed by new methods of communication and distribution. The serious harms caused by industrial agriculture and the cruelty of factory farming of animals have reached mainstream discourse, and markets for wholesome, organic, meatless, and local foods have increased, as have protests against the excessive political power of agrichemical corporations.

Beyond shareholder activism and personal purchasing power, some people use food to make a statement. Sean Sherman, Oglala Lakota chef and author of *The Sioux Chef's Indigenous Kitchen*, wrote that he does not make or encourage fry bread, often thought to be Native Americans' signature dish. To him, fry bread is a painful reminder of the injustices of colonialism.

I'm often asked why we don't have fry bread on the menu or offer a recipe for fry bread in this book. [Fry bread] originated nearly 150 years ago when the U.S. government forced our ancestors from the homelands they farmed, foraged, and hunted, and the waters they fished. They lost control of their food and were made to rely on government-issued commodities—canned meat, white flour, sugar, and lard—all lacking nutritive value. Controlling food is a means of controlling power.

Quoted in Wilson (2018, p. 3).

Food Supports Social Change

Another chef collected essays and recipes by and for activists in *Feed the Resistance: Recipes for Getting Involved*, which offers support for small groups as they gather around the table to plan their campaigns or prepare to feed large groups. Wrote one contributor, "We have plenty of work to do, and we intend to be well fed while doing it" (Zigas, 2017, p. 38). Wrote another:

Our multiracial movement building needs to be fueled by reconciliation and atonement. Food spaces and food people are unique champions to create room for, and facilitate, this healing. Unpacking this racial trauma is best served over warming bowls of peppery oxtail stew or silky dhansak. ... and white people will have to examine themselves, and with each other first; Creating anti-racist food spaces to dismantle white supremacy and patriarchy is a nourishing, worthwhile endeavor.

Simley (2017, p.80)

Slow Food USA, part of the international grassroots movement Slow Food, opposing all that fast food represents, encourages local, seasonal, and sustainable food. Furthermore, it promotes school gardens, chefs' alliances, sensible policy, and biodiversity.

Food Production

Huge machines are no longer universally seen as god's gift to agriculture. Besides the embedded energy and materials used to manufacture them, they use fossil fuels and stir up soil which is blown away and lost. But small robots bring new promise to machine-assisted agriculture. *Precision farming* (PF) is an approach in which planting, watering, tilling, and harvesting are guided by smart machines that give detailed information about each portion of the field, thus minimizing waste of seeds, water, and fertilizer and maximizing the harvest of ripe crops.

PF has the potential to increase productivity significantly, as well as reducing environmental impact the time is now right for these developments, as most of the necessary, enabling technologies such as GPS, GIS, machine vision, advanced sensors, pattern recognition techniques and autonomous vehicle technology already exist. Moreover, preliminary results suggest that robotic PF can be cost-effective.

Bogue (2013, p. 9)

The Rosphere is a ball-shaped autonomous robot compared by the researchers to the familiar pet toy Hamster ball. Rosphere is equipped with advanced electronics such as magnetometer, humidity and temperature sensors, GPS, tilt correction, and an inertial measurement unit. Having tested it on various surfaces and in cropland, the researchers concluded, "The performed tests have validated ROSPHERE's capability to move along wide crop rows while obtaining and geo-referring environmental data." Further improvements will allow Rosphere to be used on a broader variety of crops (Hernandez; Barrientos, del Cerro, Barrientos, and Sanz, 2013, p. 65).

Food and Culture

The diversity of food cultures offers a window into learning about the world. To encourage multicultural awareness among schoolchildren in California, the organization "Cooking Round the World" holds week-long summer camps and after-school classes, each focusing on a different country.

Each camp day we cook and eat 4 to 8 recipes, read a folktale, play an international/national game, observe a cooking demonstration, and learn to think critically about the foods we just cooked. In the afternoon we see a slide presentation, play a trivia game, have outside recess time, ...or bake desserts. Most weeks the focus is exploring cultures and food from around the world [showcasing] interesting cultural tidbits about the country's culture like marriage customs, family, education, toys and games, street art, how climate influences food, and fashion.

<http://cookingroundtheworld.com/camps.html>.

Indigenous peoples around the world have their own foods and traditions, which are threatened by globalization and which have attracted government and academic support. Kuhnlein (2009) noted that among 12 indigenous food cultures studied, there was a wide range in percent of traditional foods comprising their dietary intake, concluding, "A forward-looking approach is needed in all sectors to address Indigenous Peoples' food security, and for building attention on the rights of Indigenous Peoples to maintain their cultures, environments and preferred food systems" (p. 7). In Canada, The Center for Indigenous Peoples' Nutrition and Environment engages in research and participates in practical programs that honor connection to the land and the nutritional values of traditional foods.

Food Waste

One of the most unfortunate aspects of the distributed economy is the waste of food, the literal staff of life. It has been claimed for years that the world's farmers, fishers, and ranchers produce enough food to satisfy everyone on earth, but several factors prevent this optimal outcome.

- Losses during production, transportation, processing, and distribution
- Waste at destination, including rejection of slightly imperfect fresh foods
- Ill will, as when actors in distressed areas siphon off relief supplies or prevent them from reaching the intended population
- Economic opposition from large actors that obstruct innovation
- Inertia and investment in "things as they are."

Creative solutions reduce food waste. In the United States, the revived practice of growing one's own food has gained momentum. Community gardens, balcony containers, fruit and nut trees, and back yard plots are producing apples, lettuce, onions, beans, tomatoes, and more. For urban dwellers who are several generations removed from the land, planting, tending, and harvesting comprise a form of personal creativity – and an investment of time and energy that can reduce waste and the use of harmful chemicals.

High-tech inventions tackle waste: apps connect wholesalers or restaurants that have surplus to food pantries; online and delivery services distribute visually imperfect (but perfectly edible) produce that would otherwise be discarded by supermarkets; and other ingenious methods, such as a safe and edible coating for fresh produce that doubles its shelf life.

New Food Sources

Broadening our definition of what constitutes food can solve two problems at once, if we add invasive species to our menus. For instance, lionfish (*pterois volitans*) have colonized millions of square kilometers of the western Atlantic and Caribbean, outcompeting native fish and threatening them with extinction. Albins and Hixon (2013) predicted dire consequences and proposed mitigating strategies (removing them, encouraging potential natural enemies in marine reserves).

The ongoing spread of invasive lionfish throughout the greater Caribbean region will eventually be controlled either by starvation of lionfish, which would be the most extreme ending of the worst case scenario, or by native species (competitors, predators, parasites, and/or pathogens) finally providing biotic resistance to the invasion. Only time will tell whether local and regional control efforts, or simply nature running its course, will limit the potentially disastrous invasion of Atlantic and Caribbean coral reefs by Pacific lionfish. (p. 1156).

Note that the proposed solutions are expensive, bureaucratic in nature, or outside human control. But a simple solution for lionfish exists: Eating them. In fact, the market for lionfish is already established. Huth et al. (2016) also found that consumers would be willing to pay extra once they learned that lionfish were harming the local marine environment, and even more when they learned that the lionfish were threatening local commercial fish species with extinction. However, the practice of eating invasives (sometimes called "invasivorism" Snyder, 2017) must be undertaken carefully to avoid serious unintended consequences.

The Arts and Social Transformation

The arts can have direct social impact. Harriet Beecher Stowe's condemnation of slavery (*Uncle Tom's Cabin*, 1852) intensified anti-slavery sentiment and Upton Sinclair's *The Jungle* (1906) is remembered for jump-starting governmental regulation of meat packing, although that industry was only a small part of the author's denunciation of injustices in American society. *One Day in the Life of Ivan Denisovich*, Alexander Solzhenitsyn's 1962 realistic novel about Soviet prison life, launched the author's platform in the West, from which he exposed the failings of communism (and critiqued the West), donating royalties of his works and part of his Nobel Prize money to an aid fund for former Soviet prisoners and their families.

Movies (stories or documentaries) can reach vast numbers of people quickly on causes as diverse as health care, racial injustice, and the abuse of animals. Television has helped loosen prejudices and strengthen the confidence of women and minorities; for instance, the series *Roots* in the 1970s, dramatizing the abominable truth about slavery, was watched by millions, although recent events have revealed the deplorable continuance of racism and sexism in America.

Vaclav Havel, the often-jailed dissident playwright, was so respected in his country (Czechoslovakia, later the Czech Republic) that after communism fell, he was elected president and served for fourteen years. Picasso's painting *Guernica* and Goya's *The Third of*

May 1808 are among the most powerful indictments of war ever committed to canvas. Other creative forces for social transformation are theater, mime, movies, poetry, comedy, street murals, and protest songs.

Some people use the arts themselves as vehicles for social change. El Sistema is a program that began in Venezuela to teach less advantaged children to play classical music, offering alternatives to lives of drugs and crime. El Sistema has spread internationally and enrolls hundreds of thousands of children, yet is not without controversy. (One could say the same about many idealistic movements).

Theater of the Oppressed, originating in Brazil, is a collective art form purposefully devoted to social change, and uses inventive forms such as interactions with audience members to bring a social problem to life; real-life dialogues between citizens and legislators to dramatize a law's consequences; allowing spectators to interrupt a play and dramatize a more successful ending; re-enacting an oppressive incident, only with a more assertive protagonist resisting instead of acquiescing.

Professionally produced television episodes can address social problems. For instance, in South Africa, modes of financial exploitation were exposed in a soap opera television show teaching viewers to avoid loan sharks. Theater programs in prisons, such as *Shakespeare Behind Bars* and *Shakespeare for Social Justice*, promote literacy, communication skills, constructive group participation, self-esteem, and conflict resolution.

The boundary between art and social criticism has been blurred by the British provocateur Banksy, who uses graffiti and pranks to protest consumerism, war, greed, class, fascism, and a host of other traits of the modern world. Ironically, this anonymous person has become famous, and works of the artist who stays outside the art economy have become high-priced; to redouble the irony, Banksy sold one work for a million pounds, and then, as planned, it self-destructed.

However, creativity can also be used to intentionally cause harm. Terrorists invent ways to sneak bombs onto airplanes. Nazis created logistical and industrial systems for annihilating whole populations; they also used music (played by eminent orchestras led by top conductors) to whip up the crowds. Such creativity has been called "malignant" by Salio (2017), "malevolent" by Cropley et al. (2008), and the "dark side" by Cropley et al. (2010). Malevolent creativity was at work among German musicians who supported the advance of Nazism through militant songs, parades, and public concerts that celebrated their victories in the battlefield. Nazi leaders embraced the arts.

Culture was of the utmost personal importance to the Nazi leaders, many of whom were themselves failed artists – Hitler a painter and architect *manqué* as well as a passionate Wagnerian, Goebbels a would-be novelist and playwright, Goring a gluttonous art collector, Rosenberg a trained architect, von Schirach an aspiring poet. They raised culture to a central position in their so-called 'New Order' and used the arts as a means of gaining legitimacy (Spotts, 2008, p. 3).

Some of these musicians did not apparently pay a price for their collaboration with Nazis. Collaborationist conductors who continued to have careers at the highest international level after the war include Herbert von Karajan, Wilhelm Furtwangler, Karl Bohm, and Hans Knappertsbusch.

In our own day, resurgent neo-Nazis in many countries can call on the talents of web developers, writers, and photographers to promote racism, misogyny, anti-semitism, and hatred. One such group regrettably calls itself the Creativity Movement, claiming that white people are inherently superior and creative. As Salio wrote (2017, p. 30), "It is possible to identify a benign creativity, one directed at the nonviolent transformation of conflict, but also a malignant creativity implemented by those who do not even remotely intend to give up their power and privileges."

Returning to artistic creativity that expresses pro-social values, we can find photography to help war veterans heal; musical instruments being made from trash; songwriting to help the homeless and to help jailed mothers bond with their children; and bringing artists and scientists together to foster support for endangered species. These examples manifest the associative theory of creativity (Russ and Dillon, 2011, p. 66), which holds that "creative ideas occur when disparate elements come together to form a new idea or solution to a problem."

Who Is Doing It?

As Richards (2011) asserted, creativity is not limited to the eminent or the professionally trained. It is a faculty that can be employed by most people. This is particularly true in social change, where, as we have seen, useful inventions and ideas have come from children, farmers, teachers, activists, and others who were not professionally trained in the field in which they innovate (perhaps lack of training actually made their fresh insights possible). After developing their ideas, they may gather resources from other individuals, groups, or businesses in order to bring them to the target places and populations.

Children. Kindergarteners and first- and second-graders from the Homestead School in New York have since 1991 made and sold handicrafts, raising over \$128,000 to purchase and protect over 1,000 acres of rainforest in Central and South America. Twelve-year-old Haile Thomas started a program to teach underserved children about healthy nutrition. Nine-year-old Mason Perez's science fair project helped his community save tens of thousands of gallons of water. Many other children have devised and executed solutions to real-world problems. Some of these ideas were conceived independently by children, while others were submitted to projects suggested by teachers or organizations.

Teens and Young Adults. Malala Yousafzai won a Nobel Peace Prize at age 17 for advocating fearlessly, at the risk of her life, for the rights of girls to an education. Kenyan youth Richard Turere, 13, created a lighting system from castoff elements that protected his family's livestock from lions prowling at night. Eighteen-year-old Dutch student Boyan Slat designed a collection system for removing plastic waste from the Pacific Ocean, attracted millions of dollars of support, and launched it in 2018.

Organizations. There are also organizations whose mission is to support other innovators, such as Ashoka: Innovators for the Public, a charity dedicated to finding and fostering other social entrepreneurs worldwide. The Foundation Center is a nonprofit dedicated to helping other nonprofits find and secure funding. Slow Food, mentioned earlier, locates and funds inventive food entrepreneurs, emphasizing the preservation of biodiversity.

Benefit corporations (B corps). Over two thousand companies worldwide, especially those dealing with food, sustainable energy, and technology, voluntarily commit to acting with sustainable and socially positive values. The B Corp Declaration of Interdependence states:

We envision a global economy that uses business as a force for good. This economy is composed of a new type of corporation – the B Corporation – which is purpose-driven and creates benefit for all stakeholders, not just shareholders. As B Corporations and leaders of this emerging economy, we believe:

- That we must be the change we seek in the world.
- That all business ought to be conducted as if people and place mattered.
- That, through their products, practices, and profits, businesses should aspire to do no harm and benefit all.
- To do so requires that we act with the understanding that we are dependent upon another and thus responsible for each other and future generations.

In practice, B corps, which exist in 60 countries around the world, members take responsibility for their supply chains, workers' rights, carbon footprint, waste prevention, healthy environment, and racial justice. Apart from their very existence as a healthier form of doing business, B-corps make social and environmental commitments such as hiring the formerly incarcerated, reducing waste to nearly zero, moving people from welfare to work, and making carbon-neutral products.

Who Is Supporting It?

Agents of social change have received financial support from a variety of sources: philanthropists, charitable funds, government bodies, venture capitalists, industry-funded competitions, and from that well-known social invention, crowd-funding.

Unrestricted awards. Perhaps the best-known and most unusual one is the MacArthur Fellows Program, also called the MacArthur Fellowship, or "Genius Grant," a prize of \$625,000 (paid over five years) awarded annually to about 20 individuals. Recipients, who may work in any field, have no idea they are being considered for the prize. They have shown "extraordinary originality and dedication in their creative pursuits and a marked capacity for self-direction" and are citizens or residents of the United States. The unusual feature – itself creative – is that, according to the Foundation's website, "The fellowship is not a reward for past accomplishment, but rather an investment in a person's originality, insight, and potential." Their creative fields have included poetry, physics, history of religion, archeology, theater, and many others. For social change, MacArthur grants have been given to community organizers, activists, and social entrepreneurs.

Environmental awards. The Goldman Environmental Prize, sometimes called the "Green Nobel," has been awarded since 1990 to 6 grassroots environmental activists annually, one each from Africa, Asia, Europe, Islands and Island Nations, North America, and South and Central America. Each prize includes international recognition and \$175,000. For example, Francia Marquez organized women in Colombia to halt environmentally destructive illegal gold mining in their ancestral lands.

The United Nations Environmental Programme has honored individuals and organizations for their achievements in the Global 500 Roll of Honour and the Champions of the Earth. The meat alternative producers Beyond Meat and Impossible Foods won the award for their successes in successfully creating and marketing protein foods that do far less damage to environmental and human health than foods made from animals.

Foundations. The Foundation Center lists 140,000 U.S. charitable foundations. That's far too many for even a cursory survey here, but to highlight a few of the largest ones: Bloomberg Philanthropies supports projects as diverse as reducing drowning among children in Bangladesh, bypassing Washington and instead harnessing the power of mayors, and using technology to monitor the success of anti-smoking campaigns. The Bill and Melinda Gates Foundation, focusing on global health, poverty, and education, has supported projects to improve sanitation (such as funding a competition to reinvent the toilet), digital banking systems in poor countries to empower the very poor, and tackling neglected infectious diseases. Meanwhile, conservationists in the field work, often in isolation, to protect endangered species, and non-profits like Wildlife Conservation Network fund them. The Robert Wood Johnson Foundation encourages innovation by accepting "Pioneering Ideas Brief Proposals that can help us anticipate the future and meet our nation's health challenges in unexpected ways" – for example, by encouraging cities to consider mental and physical health in their building and zoning plans.

Industry grants. Even very young innovators have opportunities to showcase their ideas and win funding and practical support. For the 3M Young Scientist Lab Challenge, American students in grades 5 through 8 are invited to submit a 1- to 2-min video describing a unique solution to an everyday problem for the chance to win \$25,000 and an exclusive 3M Mentorship. Past winners include Gitanjali Rao, who invented a quick and inexpensive way to test water for lead contamination; Maanasa Mendu, who used efficient and eco-friendly piezoelectricity materials to support wind power; and Hanna Herbst, whose device taps energy from ocean currents to store in a generator. Note that all three recent winners have been girls, two of them from minorities.

Government grants. The United States federal government offers grants through dozens of its departments and administrations. State and local authorities may also fund regional or local projects, such as a California parks department plan to save the

endangered murrelet, a small bird species. Inspired by a graduate student's idea, researchers added a tasteless, odorless vomit-inducing chemical onto decoy murrelet eggs. This effectively reduced predation by Steller's jays.

Indigenous or indigenous-inspired organizations. The Redhawk Native American Arts Council, based in New York City, promotes traditional culture and contributions of Native Americans with heritage celebrations, song, dance, arts and crafts. Other Native organizations share these and other goals, and are supported by the work of Native Americans in Philanthropy.

Incubators, as they are called in the business world, are organizations such as Ashoka, mentioned earlier, through which individuals or small organizations receive support in various forms for developing their ideas. Another is the Biomimicry Launchpad, which helps early-stage innovators gain inspiration from nature to solve problems. For instance, Nexloop.us (which won the \$100,000 Ray of Hope prize in 2017) is a water capture, storage, and distribution system, based on nature principles, for supporting urban agriculture. Multiplier.org serves as an established 501(c)3 nonprofit home for startup projects, allowing them to receive funding without having to set up their own tax-exempt status, complex legal certifications, and back-office staffs.

Investors, such as New World Capital, channel venture capital to sustainability projects such as clean energy, clean energy, and water reclamation. The credo of Obvious Ventures is, "The most valuable companies of our time will be the ones solving humanity's biggest problems." Honeycomb Portfolio invests in projects that tackle sustainability, overconsumption and waste, and health of women and children.

Crowd-funding. Websites like GoFundMe and Kickstarter are known for private requests; they also acquire funds for inventors and help nonprofits hold fundraisers, collectively channeling millions of dollars directly to innovators. Many such projects are commercial; some, however, are for the public good, such as the Human Rights Campaign. Some are both, such as helping a vegan caterer establish a restaurant that serves only socially responsible dishes and also donates to community non-profits.

South by Southwest is a high-profile ten-day conference for creative change-makers, with dozens of themes plus spinoff events and networking. The track Social and Global Impact includes topics such as citizen science, gender rights, violence prevention, preserving ecosystems and species, children's rights, and framing one's work in positive rather than negative terms.

To sum up, those who dream of solving the world's problems do not have to dream alone.

Conclusion

The creative processes used to develop the many social innovations mentioned here were not typically described. But using the creativity literature, we might speculate about them. The associative theory of creativity (Russ and Dillon, 2011) suggests the value of making uncommon combinations of elements. Einstein called this "combinatorial play" and it can lead to practical novelties. For instance, robotics inventors have made surgery more precise; horseback riding helps disabled children improve their balance; raising puppies that are later trained as guide dogs helps socialize prison inmates. Ping pong diplomacy – using an indoor sport to open doors between the United States and China – was the first step in improving relations between the two countries.

Agnoli et al. (2018) pointed out that (like Wallas's classic stage of incubation) mind wandering can enhance creativity. Jiang and Thagard (2014), looking specifically at social innovation, emphasized the cognitive processes of association, analogy, and problem-solving, but also accentuated the importance of emotions such as frustration and hope, and the luck of serendipity. More generally, children have had less time to internalize the constraints of their cultures, so may be more open to fresh perspectives. Adults can consciously look beyond their assumptions and customs, exploring alternative ways of life through travel or education. Whatever the creative path they use, people of all ages, nations, races, and classes are confronting our problems with ingenuity and hope.

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Sociology

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Introduction

For several decades, creativity has attracted the attention of representatives of such sciences as psychology, including socio-psychology, sociology, philosophy, including aesthetics, pedagogy, cultural studies, economy, management, urban studies, regional studies, and, finally, bibliometrics. The sociology of creativity is interested in all the approaches above. For sociological research, not only empirical indices of creativity and not only the influence of creativity on the development of society, but also the concept of a creative society becomes important. This concept plays the role of a “cap” for empirical research.

In this entry, we first compare the different studies of creativity in the social sciences, then present the concept of a creative society, and finally analyze the possible indices of a creative society and their problems.

Studies of Creativity in the Social Sciences

Table 1 shows the areas and sub-areas of creativity studies in the social sciences. Since the social sciences differ from, say, the humanities, by adopting a more or less empirical approach, the table also includes the indicators of creativity. It seems that creativity is first and foremost a topic for the humanities and arts, but in this entry we will limit ourselves to creativity research that is interesting for a sociological approach. The humanistic (say, philosophical) approach is as important here as it complements the sociological one. For example, the very definition of creativity inevitably appeals to philosophy as a view from the outside. **Table 1** does not exhaust all possible approaches to creativity. For example, technological sciences also deal with creativity.

First of all, the phenomenon of creativity attracted the attention of psychologists. The empirical research into the psychology of creativity is since the 1950s. In the seventh decade of the last century, an empirical test of creativity was launched (Torrance, 1966). In addition, relatively long ago, psychologists also realized the negative aspects of creativity (Rank, 1989/1929). Negative aspects can be assessed as the limits that imply the ethics and ecology of creativity; therefore, they are extremely important for the concept of a creative society. Following the Torrance test, various indicators of creativity were proposed, including an imagination index. For example, tolerance for uncertainty, which usually accompanies creative initiatives in society, was analyzed (Kornilova and Kornilov, 2012).

Researchers analyzed different psychological aspects of creativity, which is primarily related to originality, as well as the relationship between creativity and certain behaviors or characteristics that are inseparable from the social environment. As a result of the interweaving of the psychological and sociological areas, in the case of creativity, different integrative indices are introduced (Reiter-Palmon et al., 2009), as well factors (Carroll et al., 2009) to measure creativity and its role in society, including SEKI (Chang et al., 2014), IPK (Carroll et al., 2009) and OKFTA (Kaufman et al., 2009).

As mentioned, a scientific approach to creativity does not do without a specific meta-science, i.e., an outside view that helps determine the phenomenon itself and its social role. It seems that any scientific discourse should begin with this philosophy. On the other hand, this also requires a certain framework, in our case, a sociological context. When defining creativity, researchers refer to etymology (Amabile, 1983; Runco, 2004), semantics and hermeneutics (Uggla, 2017). Beside this, we can speak also about the phenomenology of creativity. The structural approach to this extensive term also helps to understand the phenomenon (Simonton, 2012). Attempts to evaluate academic creativity by citing scientific publications (Hirsch, 2005) can also be attributed to approaches from the outside. In this case, we are talking about a bibliometric approach.

Social criticism, which usually refers to Karl Marx, primarily attempts to evaluate creative work, in which exploitative elements are not excluded. In this regard, the concept of a creative class (Florida, 2002) also does not avoid references to the Marxist division of society into classes according to professional characteristics. On the other hand, from the Marxist standpoint, one can analyze the creative potential of the working class, in whose hands is the creation of a new society.

Table 1 Scientific approaches to creativity (C).

<i>Scientific areas</i>	<i>Sub-aries</i>	<i>Creativity research indicators</i>	<i>References</i>
Psychology	Psychosomatic processes	Torrance test	Torrance, 1966
		Psychological indices of creativity	Runco, 2004
	Solution of creative problems	(Un)tolerance for uncertainty	Kornilova and Kornilov, 2012
		Multiple Creativity Index	Reiter-Palmon et al., 2009
Philosophy	Socio-psychology of creativity	Factors of creativity	Carroll et al., 2009
		CSI (Creativity Support Index)	Carroll et al., 2009
	Self-expressing creativity ratings	GCFTA (General Creativity Factors of Thematic Areas)	Kaufman et al., 2009
	Definitions of creativity	Etymology, semantics and hermeneutics of creativity	Amabile, 1983; Runco, 2004; Kornilova and Kornilov, 2012
Sociology	Meta-science, definitions of creativity in academic writing	Hirsch Index (H-index)	Hirsch, 2005
	Meta-creativity	Negative aspects of creativity	Rank, 1989/1929
	Aesthetics	Creativity in art	Juzefovič, 2015
	Social theories	Creative environment	Baltrėnas et al., 2015
Pedagogy	Climate of creativity	Indices of a creative climate (environment); factors of correlation between climate and creativity	Baltrėnas et al., 2015
	Quantitative methods (surveys, calculations)	Mathematical models for calculating creativity	Carroll et al., 2009
Pedagogy	Pedagogical methods	Predictors of creativity	Juzefovič, 2015

Speaking of philosophy in a narrower sense, it can be noted that its aesthetics section deals with issues of creativity in art (Juzefovič, 2015). In this case, the social environment plays an important role (Baltrėnas et al., 2015). Creativity is also analyzed as a pedagogical factor (Juzefovič, 2015).

Research on economics and management analyzes the issues of innovative products on the market, cultural (creative) economy (Howkins, 2007), and intellectual capital related to creative capital (Florida, 2002).

Regional studies raise questions about the creative factors in the development of both cities, and insufficiently urbanized regions. In addition, urban studies are engaged in establishing sociocultural qualities, assessed by creative industries, cultural clusters and creative products in the city.

So, sociology faces issues of creativity at four levels: (1) relying on certain sociological theories, (2) analyzing the social environment of creativity, (3) applying qualitative sociological methods to the study of creativity and (4) searching of empirical indices of creativity.

The Concept of Creative Society

As can be seen from the above, the concept of a creative society has a solid basis. Creative industries suggest the creative class as a new social formation (Florida, 2002). It seems the creative class is the core of a creative society. The number, weight and activity of the creative class predetermines the role of creativity in society. Still, there are several problems here. First, the creative class is not a new formation. It can even be considered the criterion of any outstanding historical civilization. Secondly, it is unclear how to define the creative class. If we define the creative class too narrowly (say, only as a class of artists), its role in society will be insignificant. If we define it too broadly (including engineers, doctors, bankers and businessmen) in the manner of Florida (2002), it will lose his identity. Finally, the concept of a creative society presupposes the idea that every individual is creative enough. There is no reason to speak about a creative class in this case. Although the segregation of our society increases, the division of it into the classes is a kind of Post-Marxist discourse if everybody has equal possibilities within a democratic environment. As a result, the concept of creative society represents a neoliberal approach that is hardly compatible with a Post-Marxist division of society into the classes (including creative one) as the holders of social capital.

Additionally, the question arises about the relationship between the knowledge society and the creative society. It seems that creativity requires more and more knowledge and skills in an environment filled with technology and media. As a result, creativity occurs in a knowledge society where creativity is only an aspect of promoting knowledge. Still, creative relationships imply entirely different social ties that predetermine changes in both labor relations and lifestyle. In addition, the priorities of creativity predetermine political changes. Finally, the fact that creativity is inseparable from knowledge does not mean that the first is an aspect of the second, and not vice versa. So, the discourse of the knowledge society does not remove and does not subordinate the discourse of the creative society, since the latter emphasizes the corresponding trends in social development.

Another aspect of creative society—that it or a part of it, such as a class or an individual—is something outstanding. We encounter this aspect or phenomenon in several ways. First, we are talking about an outstanding artist in a narrow and about an outstanding creative worker in a broad sense. But this is a problematic issue. On the one hand, any artist or creative worker is a child

of his or her environment, who also plays a certain role in this process. On the other hand, an outstanding individual also implies a hermeneutic and communication gap, that is, a lack of understanding and ignoring of his (her) work; finally, outstanding individuals are undesirable in a media environment where ratings and mass audience are priorities. Secondly, we can talk about an outstanding community, including a class. For example, the creative class (if we recognize this) is outstanding both because of its creative achievements and due to its influence on society, although it is not the largest class. The problem here is that in a democratic society with its majority rule, a relatively small creative class can hardly influence political decisions. This suggests an unpleasant idea that a democratic and creative society do not agree. Some researchers (Florida, 2002) try to solve this problem by expanding the scope of the creative class, but this creates difficulties in identifying it.

As mentioned, we can talk about an outstanding creative society. In this case, we face another difficulty: if a society is understood as a social community encompassing individuals and communities, then is it outstanding in relation to what? A creative society can be outstanding unless in relation to a knowledge society or an industrial society, which imply a different theoretical approach and other priorities. However, in this case it does not indicate different societies, but the development of the same society, when certain aspects become irrelevant.

The creative society involves a creative lifestyle. The changed labor relations show it: freedom in choosing work schedules, long vacations, which are most often sacrificed for creative work, informal relations, when offices and institutions that administer creativity disappear, autonomy and responsibility in making both working and life decisions, inability to count working hours, on the other hand—hard work, short-term duties to the employer and consequently reduction in social guarantees. In other words, the creative worker balances between the desire to go beyond formal labor relations and the obligation to remain inside the labor market with some social protection. In general, the social life of a creative worker is varied in form. Still, in most cases we are not speaking about waiting for rare moments of inspiration, but about hard work and self-discipline. Finally, both the creative worker and the creative society are characterized by the principle of ignorance. It manifests itself not so much in ignorance about the future impact or success of the work, but also in ignorance of what will affect the emergence of the work.

The question arises whether there is a limit to creativity. Thus, it is a question of creative ecology and creative ethics. Each work of art, more or less individual, is limited by its social environment, which it puts forward or forgets. Creative ecology primarily appeals to the purification of consciousness from creative pollution (Howkins, 2009). The creative ecology is a certain strategy for forming the content of consciousness. This is necessary both for individual creativity and for the renewal of society. Ecology is a narrow transition between social mobility and social stagnation. In general, for ecology, individual creativity in the conditions of social engineering and the production of mass happiness is important. The expansion of the social horizon for individual creativity, which always arises in a certain social environment, is also connected with ecology.

Creative ethics also appeal to the limits of creativity, although it interprets stagnation as unethical behavior in relation to the creative society. A colorful creative society without the same rules implies different behavior. Although Immanuel Kant associated ethics with reason and rationality, creative ethics encounters irrational moments when the behavior of an individual is predetermined by his creative sensations and stimuli. We can talk about two sections of creative ethics: the content of the first is the creative aspect of ethics, the second is the ethical issue of creativity. On the other hand, one can speak of three ethics by social dimension: an individual, a communal, and a social. The first covers the aspirations of the creative worker, the second appeals to the professional activity, the third has in mind the universal maxims. A creative worker is an agent of all these ethics and their sections. Moreover, certain tensions or even contradictions between these ethics become creative stimuli. Creative ethics appeal to the unusual behavior toward these contradictory ethics, although it seems unethical from other ethical perspectives.

Empirical Research of Creative Society

The difficulties specific for empirical studies of creativity stem from the non-empirical nature of creativity. From a sociological point of view, studies of a creative society need empirical indices of creativity. Therefore, Florida puts forward certain indices of creativity: Bohemian, High Tech, Innovation, Gay, Talent, Melting Pot, and their integrative indices (see Table 2). It seems that it remains to count them, to evaluate national, professional and religious communities, as well as to form policies that encourage creativity. But here the problems are just beginning. With respect to each of these empirical indices, methodological difficulties arise that cause doubts in the empirical approach to creativity in general: either these empirical indices do not sufficiently substantiate creativity, or they cannot be counted empirically.

For example, in the case of a Bohemian Index (that refers to creative workers in the narrow sense or artists) it is not clear who makes up this group. Are performers, (computer) designers, inventors, educators, scientists, DJs, graphitists considered as artists? Here a problem arises, as in the case of the creative class. Wanting to give a great influence to this concentrate of creative society, researchers tend to expand its boundaries, but then there is a threat to its identity. In addition, it is difficult to separate the artist from the manager and technologist in a post-modern and post-industrial society. Finally, it is unclear how much the artist must be outstanding in order to be counted among this layer. So, the volume of the Bohemian Index depends on the question arising from the policy in the field of art and creativity: how much does a consumer community need an artist with his disinterested vision?

When we try to determine the High Tech Index, first of all there is the difficulty of separating high technologies from “low” technologies. In addition, high technologies are becoming a means of leveling creative activities instead of encouraging creativity. It seems that the Innovation index, which is determined by the number of patents, speaks not so much of creativity as of a lower

Table 2 Indices of creativity R. Florida.

No.	Index	Integrative	Indices
1.	Bohemian		
2.	Melting pot	Minor integrative	
3.	Gay	(Diversity) index	
4.	High tech	–	Major integrative index
5.	Innovation	–	
6.	Talent	–	

or higher social barrier in this regard. Moreover, the number of patents does not show the influence of inventions on social development after their implementation. Finally, the growth in the number of patents shows trends not so much creativity as consumption.

It is impossible to measure the Gay Index not only because statistics on this “sensitive” issue is hardly possible, and the phenomenon of bisexuality indicates that the boundaries of homosexuality are unclear. Difficulties result from the fact that being gay is primarily a cultural, not a physical (sexual) category. The Talent index, which expresses the percentage of high school graduates, indicates not as much the talent (and thus creativity) of society as the attractiveness of higher education. A high Talent Index also shows a devaluation of higher education, i.e. an orientation toward the average level, which is the opposite of creativity. The Melting Pot Index, which expresses the percentage of immigrants, does not show the diversity (which implies creativity) of society, but the probable closeness of sub-societies. In addition, the idea of a pot leveling cultural margins does not express creativity, which appeals to the cooperation of the cultural center and cultural margins. The empiricity of integral indices (Minor and Major), which at different scales cover the mentioned indices, is questionable not only because their components are problematic and difficult to measure, and not only because they cover only part of the possible creativity indices, but also because that they appeal to what is behind empiricism, i.e., to historical consciousness, worldview and transmission of tradition.

In addition to those mentioned above, alternative creativity indices can be advanced. For example, the Emigration Index, which in some sense is the opposite of the Melting Pot Index, as it appeals to emigrants, and not to immigrants. Still, it expresses the freedom and tolerance of society: the least of all emigrants are from a totalitarian society, which can hardly be called creative. The Suicide Index seems to express the unhappy state of society, which is not consistent with creativity. Still, he shows the freedom of “exit” in a creative society. The indices of economic growth, sociability and urbanization also express creativity, although not in a straightforward way. Economic growth implies more intensive creative activities. Sociability (including social networks) involves the exchange of creative ideas; a large number of cities and their sufficient size presuppose additional creative possibilities.

Conclusion

The sociology of creativity is interested in different inter-disciplinary approaches including socio-psychology, philosophy of creativity, cultural studies, urban studies, bibliometrics etc. For sociological research, not only empirical indices of creativity and not only the influence of creativity on the development of society, but also the concept of a creative society becomes important. Sociology faces issues of creativity at four levels: (1) relying on certain sociological theories, (2) analyzing the social environment of creativity, (3) applying qualitative sociological methods to the study of creativity and (4) searching of empirical indices of creativity. Additionally, the concept of a creative society has a solid basis. The creative society involves also a creative lifestyle. The question of creative society arises whether there is a limit to creativity. Thus, it is a question of creative ecology and creative ethics. The difficulties specific for empirical studies of creativity stem from the non-empirical nature of creativity. However, from a sociological point of view, studies of a creative society need empirical indices of creativity.

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Sport

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Creativity in Sports and Performing Arts

The sport environment is more challenging, unpredictable, and distracting than ever before. Athletes aspiring to the top level must reinvent themselves on a regular basis to keep an edge on their competitors. Whether it is to create novel and irregular movement patterns, or perform versatile tactical decisions during game play, creativity has become a crucial asset for the achievement of excellence in sport (Santos et al., 2016). Consequently, this entry presents an overview of the scientific literature related to creativity in the motor domain. It aims at describing terms, processes, measurement tools and resources to draw an accurate portrait of the state of the knowledge about creativity in sport and performing arts.

Motor Creativity

Bodily-kinesthetic or motoric creativity can be expressed differently depending on whether an individual is faced with the conditions characterizing artistic or acrobatic motor activities or with the conditions depicting team games. On one hand, the combination of perceptions into new motor patterns that is either a solution to a pre-established problem or the expression of an idea or an emotion by the means of the human body can be defined as *motor creativity* (Bournelli et al., 2009). Multiple sport breakthroughs resulted from sculpting new movement patterns. For instance, in 1968 Mexico Olympics, Dick Fosbury won the gold medal in high jump and set a new world record using an innovative, radically new approach. Instead of jumping over the bar face first, Fosbury decided to turn as he left the ground such that his back was to the bar. The Fosbury “flop” marked a revolution for the sport of high jumping. In 1970, gymnastics also progressed tremendously, largely because of the immense creative talent of Mitsuo Tsukahara. To compensate for an inability to locate himself in the air, the Japanese gymnast created the “Tsukahara vault” and thereby transformed the direction of vaulting by adding twisting to rotation. Although not competing for medals when they get on stage, performing artists such as dancers and circus performers are also pushing movement innovation to blow the mind of spectators show after show.

Tactical Creativity

Creativity in sport can also be expressed by athletes through unpredictable decision making in interactive, open-skill sports. Unexpected tactical solutions to situations that appear unresolvable to others can take the form of a surprising no look pass, a dribbling move to outsmart a defender, or a novel running routes to get a teammate open for a pass (Kempe and Memmert, 2018). The capacity to take varied, rare, and flexible decisions during game play is referred to as *tactical creativity* and is nowadays considered as a decisive factor for team sport success (Memmert, 2015). For instance, the examination of the eight actions preceding all goals in the Football FIFA World Cup 2010 and 2014, as well as the Football UEFA Euro 2016 revealed that teams exhibiting the highest level of tactical creativity are those that advanced to the later rounds of the tournament (Kempe and Memmert, 2018).

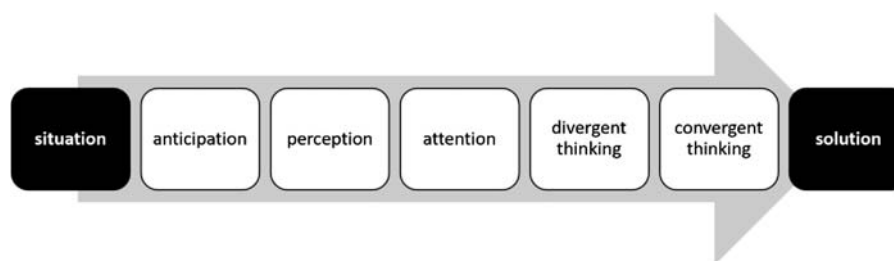


Figure 1 Cognitive processes underlying optimal decision making in team sport (Memmert, 2015a).

Psychological and Historical Creativity

Although the examples provided so far are showcasing outstanding demonstrations of creativity in the motor domain, developmental expression of creativity is not to be ignored. Similar to the everyday – eminent creative behaviors continuum, motoric creativity is classified in two main categories: *psychological creativity* and *historical creativity*. The former entails the discovery of a functional motor behavior that was not a part of the initial performers “repertoire.” In other words, creativity can happen without regard to whether such solutions already exist in the socio-cultural environment of the performer (Hristovski et al., 2011). The latter represents unique, socially recognized movement innovation, as exemplified by Fosbury and Tsukahara. To better capture the mechanism underlying creativity in the realm of motor performance, the following section provide an overview of a cognitive and an ecological dynamics framework.

A Cognitive Framework

According to the cognitive conceptualization of creativity, ideas are first generated in the mind, and then transformed into motor behaviors. Hence, divergent thinking – the cognitive process of generating many alternative ideas – may be a prerequisite for being creative in movement. Empirical evidence support that assumptions by highlighting overlaps in the processes conducive to the generation of creative thoughts and movements (e.g., Scibinetti et al., 2011).

Divergent thinking (DT) is also involved in the generation of creative tactical solutions during game play (Memmert, 2015). As illustrated in Fig. 1, DT is one of many cognitive processes leading to optimal decision making which refers to the process of making a choice from various options with the potential of having crucial consequences. Specifically, an athlete first anticipates and perceives a sport situation based on past experiences. The player then attends to visual cues in the environment and directs his/her attention to the most relevant ones. With these visual cues and knowledge in mind, divergent thinking allows the athlete to generate a range of ideas. Convergent thinking subsequently guides the athlete towards the best possible solution to be executed. Finally, if changes occur in the environment, alternative solution(s) can be explored and executed (Memmert, 2015).

Since DT is considered a good predictor of creative potential, sport researchers used general DT tasks to examine the link between creativity and motor expertise. For instance, Richard et al. (2017) showed that world class and Olympic athletes exhibited significantly higher DT score than non-expert athletes. The difference was particularly clear in ideational flexibility. Professional dancers, on the other hand, produce a larger number of ideas (fluency) than novice dancers (Fink et al., 2009). These results extend the report of a trend with skilled handball players outperforming non-skilled players on DT tasks (Memmert, 2015). Despite this evidence, the degree to which this high level cognitive skill is required for generating creative motor responses is still under debate. Creativity being a domain-specific skill, it is not certain that creative thinking will transfer into specific creative motor behaviors.

An Ecological Dynamics Framework

Orth et al. (2017) recently challenged the traditional cognitive view by using an ecological dynamics perspective. Rather than considering action as a mere expression of the creative cognitive system, they argued that creative motor solutions emerge through perception-action coupling within the environmental constraints. The structure of the physical environment, biomechanics of the body, perceptual information, and task demands determine the boundaries within which the motor system can act influencing the repertoire of actions available (Seifert et al., 2016). Moving creatively thus reflects an individual’s capacity to adapt in a unique and original way (Hristovski et al., 2011).

Both movement stability and flexibility are essential components of adaptability when individuals are encountering constraints. Behavioral adaptation thus comprises both adapted and adaptive behaviors. Adapted behaviors denote behavioral stability against perturbations whereas adaptive behaviors solicited behavioral flexibility to generate functional solutions under interacting performance constraints. Flexibility is thus an indicator of adaptation because it facilitates changes in behavioral patterns while preserving functionality. Also called degeneracy, this flexible motor adaptation is what leads to creativity and innovation (Seifert et al., 2016).

Measurement of Motor and Tactical Creativity

Whether we adopt a cognitive or a behavioral view to explain how creative movements and tactical decisions are produced, both frameworks support the idea that creativity can be nurtured in athletes and performers (Santos et al., 2016). Therefore, assessment tools were designed to directly tackle the improvement of creative motor behaviors.

The Motor Creativity Test (MCT), Thinking Creatively in Action and Movement (TCAM), the Bertsch task, and the Divergent Movement Ability test (DMA) are instruments that aimed at differentiating children ability to produce creative kinaesthetic responses to problem of a motor nature. To investigate motor creativity in adult population, an agility ladder task has recently been developed (Moraru et al., 2016). These assessment tasks encourage participants to solve motor problems in as many ways as possible by producing original movements. Methods using sport-specific movement video analysis also exist. These look at the transformation of traditional movement technique into more innovative ones (Torrents et al., 2015).

To assess the creative decision-making process, two methods are most frequently used: *video test* and *game test* situations (Mehmert, 2015). *Video test* presents highly standardized scenarios that require athletes to imagine themselves as the acting player in clips showing a sport-specific offensive play. When an offensive decision must be made, the image is frozen, and the athlete must name as many solutions as possible in relation to what he/she sees. Presenting a higher ecological validity, *game test* situations are ball games involving a single tactical component at a time, with fixed numbers of players as well as defined rules and environmental conditions. Creativity ratings of a chain of actions (e.g., dribbling, crossing, passing, or ball transport) leading to a desired sport outcome (e.g., scoring a goal) during official games is the most ecological method to assess tactical creativity (Kempe and Mehmert, 2018).

The behaviors exhibited during the various creativity tasks are usually video recorded and rated by several independent sport experts or trained assessors. As with divergent thinking tests, *fluidity*, *flexibility*, and *originality*, are among the criteria frequently used to evaluate participant's motor responses (Mehmert, 2015). *Fluency* denotes the ability to produce many movements or strategies; *flexibility* refers to the ability to generate motor solutions that pertains to different categories; and *originality* represents the capacity to generate seldom motor responses contrasted with a sample dependent norm.

Resources Supporting Motor and Tactical Creativity

The sport-specific creativity instruments presented in the previous section are frequently used to elucidate under which conditions creative motor behaviors blossom. Cognitive, affective, and environmental resources interact together to support the emergence of creative behaviors. Therefore, the next section highlights how those specific resources influence motor and tactical creativity.

Cognitive Resources

Anchored in a cognitive perspective, sport expertise is linked to superior executive functions. This umbrella term overarching cognitive processes such as working memory, attention, and inhibitory control is necessary for the regulation of thoughts and behaviors. Creativity is also associated with higher-level cognitive functions. Hence, investigating the potential linkage between executive functions and creativity in the motor domain is a valid method for testing this claim.

For example, working memory maintains new information in a heightened state of availability. Consequently, larger working memory capacity (WMC) is thought to allow individuals to override the tendency to stick to more traditional readily available solutions. In the motor domain, taxing working memory was not predictive of the diversity of motor solutions nor the originality of responses in both adult (Moraru et al., 2016) and children (Scibinetti et al., 2011) populations. Studying the impact of domain-general WMC on experienced soccer players' tactical creativity revealed similar results (Furley and Mehmert, 2015). Because a -potential solution is strongly activated by an expert's prior knowledge, high level WMC may fix the individual attention on the well-known solution, preventing more novel ideas from being explored.

Attentional strategies may thus facilitate creativity. Specifically, attending to a broad range of stimuli (i.e., broad focus) enables the access to distant and diverse ideas which, when connected together, lead to increased flexibility and originality. This holds true in sport. For instance, evidence highlighted the positive influence of a 6 months attention-broadening training program on tactical creativity in children. In this vein, evidence showed that advanced handball players who noticed the open player in an inattentional blindness paradigm video task produced significantly more original and flexible tactical solutions than those who missed it (Mehmert, 2015). Using eye-movement registration system to compare the visual search strategies of most-creative and least-creative soccer players, the positive role of broader attention was confirmed. The most-creative players detect a greater number of well-positioned teammates and they noticed them faster than their least-creative counterparts (Roca et al., 2018).

A slightly different trend was observed when examining the impact of breadth of attention on motor creativity. After priming either broad or narrow attention, Moraru et al. (2016) found that motor flexibility - but not originality - is affected by broad attention. Facing a motor task, a broad focus may trigger the performance of different modes of locomotion. Yet, because the task requires motor capacity, low skilled individuals may be unable to express in movement the responses of their original thinking process. In other words, broadening attention may only impact motor originality in population exhibiting greater physical literacy - the ability to use cognitive processes to move with confidence in a range of environments.

Likewise, original movement production is influenced by cognitive inhibition. Scibinetti et al. (2011) showed that while high level of inhibitory ability is predictive of original movement generation, originality in creative thinking is associated to low levels

of inhibition. Lower inhibitory ability is known to allow the emergence of loosely connected associations facilitating the production of original ideas. However, the planning of more complex movement output may require higher inhibition abilities to suppress the production of more common routines and let alternative movement ideas come to mind at least in a children population.

Not considered as an executive function, domain-specific knowledge is nevertheless a mandatory cognitive resource to innovate and push a field further. Although this is well accepted, the preferable method to acquire this knowledge remains an active debate in the motor domain. The next section shed light on this debate by exposing the optimal environmental learning and training conditions to foster creativity in the motor domain.

Environmental Resources

To master motor skills, deliberate practice is known to be an efficient method. Broadly defined as the engagement in highly structured training activities, extensive amount of *deliberate practice* hours is associated with greater level of tactical creativity in athletes of various team ball sports (Memmert, 2015). Yet, physical literacy also benefit from diversification and freedom (Santos et al., 2016). Because it promotes a broader spectrum of experiences and outcomes, diversification of motor activities during the first phases of athletic development favor the enhancement of creativity (Santos et al., 2016). Accordingly, accumulated hours of *deliberate play* – an informal involvement in sport games designed to maximize enjoyment – is linked to increased tactical creativity in young athletes (Memmert, 2015). This in turn suggests that creativity may not only benefit structured expert knowledge, but also need to be supported by modifiable cognitive representations.

To promote the acquisition of innovative and functional movement patterns, Hristovski et al. (2011) suggested a model of neurobiological creativity grounded in an ecological dynamics perspective. Because performers neurobiological system is complex, it provides a platform for multi-stability (i.e., the capacity to possess many co-existent patterns forming propensities) which is a prerequisite for metastability to happen. When the environment is designed to trigger meta-stable regions of the performance landscape, performers' system momentarily dwells between stability and instability. To efficiently deal with the chaos and regain stability, they must generate co-adaptation strategies to transition to novel, more adapted states of organization. Nonlinear pedagogy represents a key principle to create chaos in the performer 'motor system because it challenges the neurobiological system's action degrees of freedom (Schöllhorn et al., 2012). Constraint-led, functional variability, differential learning, and improvisation are examples of evidence-based nonlinear methods that have been associated to motor and tactical creativity enhancement.

Constraints-led training stimulates the discovery of a myriad of movement solutions or benefit a deeper investigation of a fewer ones (Orth et al., 2017). By manipulating individual, environmental and/or task parameters according to the unique performers initial characteristics, it induces uncertainty leading to a reorganization of strategies to solve motoric problem. For instance, Torrents et al. (2015) explored the effect of evolving constraints on 3 pairs of contemporary dancers. While dancers were free to move in any way they wanted with their partner in the first condition, they were instructed to keep their pelvis as close as possible in the second condition and as far as possible in the third condition. Results indicated that task constraints had a significant effect on the type of configurations performed by the dancers. The capacity to vary motor behavior without compromising its functionality improved under similar constraint conditions in several sports.

Functional variability implies changing the task (e.g., random practice) or the context (e.g., context interference approach) from one repetition to another to force constant cognitive reconstruction triggering the instigation of different solution pathways. In boxing, for instance, continuous subtle changes in the scaled performer-target distance led to spontaneous and novel striking techniques that had not been practiced or taught before (Hristovski et al., 2011). Adding movement variability in soccer drills targeting passing and shooting skills also triggered substantial positive alterations in motor behaviors (Schöllhorn et al., 2006).

Considered highly nonlinear because the performer's motor actions are constantly challenged by stochastic perturbations, *differential learning* does not identify key task constraints. Instead, it amplifies preexisting fluctuations in the performer's subsystems to initiate self-organization processes and allow the emergence of novel and more effective movement patterns (Schöllhorn et al., 2012). Different programs asking performers to display movement under constant perturbations (e.g., eye closed, hand tied, variation in ball size, etc.) in random order impacted positively creative behavior and technical game performance in other performers.

The unexpected facet of differential learning is comparable to the demand of improvisational activities. Being one of the most complex form of creative behavior (Santos et al., 2016), improvisation forces individual to break away from pre-established patterns. Inspired by *Cirque du Soleil* artistic classes, improvisation techniques were employed to help elite figure skaters free up their performance. Not only quantitative measures of creative attitudes and values improved, but skaters reported being more open-minded and willing to take risks following the intervention (Richard et al., 2017). Similar effects of improvisation was also observed in dance.

Integration of the nonlinear methods resulted in designing programs aimed at enhancing kinesthetic creativity in children. Firstly, the Skills4Genius program showed that by integrating problem solving, diversification, ludic fundamental skills games, and moderate contextual interference children stretched both creative thinking and in-game individual creative behaviors (Santos et al., 2017). On the other hand, Creative Champions metamorphosed a conventional fitness program into a more creative one. The use of constraints, variability, fantasy play, problem solving and improvisation to encourage children to move differently resulted in significantly more original thoughts, as well as fluent and flexible movements compare to

the children that continued the conventional exercise program (Richard et al., 2018). The impact of a creativity supportive environment on the fluency, flexibility and originality of movements and tactics may be mediated by affective variables which are reviewed next.

Affective Resources

Laborde and Raab (2013) compared the impact of positive and negative moods on the option-generation process in handball players of different expertise levels. The absence of significant interaction between mood and the number of option generated by players contradicts previous evidence stating that positive mood affects the way people make decision. The fact that only hedonic tone was considered to assess mood can in part explain this discrepancy. In addition to the positive and negative characteristics of mood, regulatory focus and activation are highly influential in idea generation process. Positive mood combined with promotion focus has shown the strongest positive association with creative behaviors.

In this vein, researchers examined whether priming promotion or prevention regulatory focus influence sport-specific creative solutions in a dynamic video soccer task (Memmert, 2015). Promotion focus refers to attending to accomplishments and aspirations whereas a focus on safety and responsibility is labelled prevention focus. Findings revealed that athletes in a promotion mode produce more adequate, original, and flexible tactical solutions than those in a prevention one. Social prime was also used to test whether listing the characteristics of a creative soccer player (e.g., Lionel Messi) or a non-creative one (e.g., Per Mertesacker) was activating cognitive concepts associated with creative response tendency when performing a soccer decision making task. Interestingly, neither mood nor motivation were significantly influenced by social prime. Yet, athletes that described the creative player exhibited substantially more fluent and flexible decisions in the soccer task than the one primed with the non creative player thereby confirming the cognitive activation hypothesis (Furley and Memmert, 2018).

Personality is considered as an additional affective resource associated to creativity. For instance, Fink and Woschnjak (2011) demonstrated that modern/contemporary dancers, who presented a greater creative potential, were somewhat more open to experiences than ballet dancers and less conscientious than both jazz and ballet dancers. The discrepancy in personality traits expression between these different groups can be attributed to environmental conditions. The adherence to strongly predefined scripts in ballet may account for the low level of creative traits exhibited by these performers.

Conclusion

To conclude, the increasing number of scientific work targeting creativity in the motor domain over the last decades point towards the importance of nurturing motor and/or tactical creativity to optimize performance throughout the athletic development. Although cognitive and ecological dynamics frameworks dominate the literature, more research must be conducted to confirm the pathway of creativity occurrence. Nevertheless, setting appropriate environmental conditions and triggering optimal cognitive and affective resources are promising solutions to foster creativity in performers. By unleashing their motor and/or tactical creativity, performers make sports more exciting and performing arts more aesthetically attractive (Hristovski et al., 2011).

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Stress

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Introduction

The relationship between stress and creativity is complex. Variations in findings have elicited positive (e.g., Baer, 1998), negative (e.g. Amabile et al., 1990), and curvilinear (e.g., Landon and Suedfeld, 1972) relationships between stress and creativity. Context has also been found to impact the influence of stressors as demonstrated in studies of workplace stress, which found that idea generation was impacted by the meaning derived from the work as seen from the employee's perspective (Ren and Zhang, 2015). Our busy lives are constantly bombarded by varying types and degrees of stressors that affect our productivity at work, in school, and at home. This entry begins with a review of the research on creativity and stress from three viewpoints found in the literature, ways in which stress increases creativity, how stress decreases creativity, and how stress can activate and increase creativity to a point, with too much activation diminishing creative output. The entry will conclude with research examining developmental aspects of this debate, adaptability, and the effects of the internet on perceived stress and its relationship to creativity.

Models of the Relationship Between Stress and Creativity

As a precursor to the review of various theoretical models and their explanations of the relationship between stress and creativity, a definition of terms will be provided. In a review of workplace stress and ideation, Byron et al. (2010) used a stimulus definition of stress, emphasizing a focus on stressors, including physical (e.g., noise), or psychological (e.g., evaluation) conditions that require an adaptive response. Though creativity involves both an emphasis on process and product, this entry focuses on the product aspect to address how stress impacts productivity—the production of ideas, solutions, or products that are novel and appropriate in a given situation.

Theories in support of the perspective that stress reduces creativity include distraction arousal theory which suggests that individuals have limited mental resources and that stressors use a portion of these resources leaving fewer mental capacities available for use to complete the task at hand. More complex problem solving techniques are perceived to be used first, leaving more simple mental abilities to be used later (Teichner et al., 1963), as in narrowed attentional focus (Eysenck, 1995). The simple mental abilities are thought to limit the novelty of problem solutions, thus reducing creativity (Baron, 1986).

In the context of creativity in the workplace, factors such as chronically high workload pressures have been reported as harmful to creativity (Amabile et al., 1996). Chronically high workload pressures exist in environments that regularly involve mindful and cognitively challenging tasks, have high imposed time pressures for task completion, frequent interruptions as multiple tasks compete for priority, and reduced control over timing, pacing, and quality of work product as supervisors rearrange schedules to make up for time deficiencies. Hallowell (2005), a psychiatrist, asserted that organizations may be in a state of experiencing long-term underperformance and lack of creativity due to chronic stress and intense workload pressures. In studies of workplace stress and creativity, he also found that chronically over worked employees were starting to exhibit signs of an attention deficit trait—a state typically characterized by “distractibility, inner frenzy, and impatience”—completely caused by one's environment (compared to attention deficit disorder symptoms caused by both physiological and genetic components) (Hallowell, 2005, p. 1).

These high workload contexts would qualify as both high in job demand and low in job control, components of models of job strain (Karasek, 1979). Likewise, the cognitive constraints and diminished creativity of environments impacted by employees' belief that they have little control over their work environment can be compared to individuals living in high crime, high poverty neighborhoods where many stressors have been found to decrease creativity as a results of residents believing that they have little control over their circumstances (Porter, 1995, 1998; Chand O'Neal et al., 2020).

Theories emphasize the finite cognitive resources available for problem solving, underscoring that dealing with the pressure of a tight deadline, or challenges with a colleague, drain a great deal of the cognitive resources leaving little energy left to finish the work. How does a company create the ideal work environment offering challenging tasks with little external stress? One answer has been the recognition by employers that work stress can take a toll on productivity. To address this burden, companies are encouraging workplace wellness to combat workplace stress. Emerging in a number of highly productive companies are such

initiatives as revamping work habitats, allowing for flexible hours and remote working, providing opportunities for socializing with colleagues, providing onsite and distance counseling, and recognizing employees for exceptional work.

The expression, “Necessity is the mother of invention,” is based in the perspective that stress increases creativity. This viewpoint is supported by studies on arousal, which suggest that stress increases arousal which stimulates the use of creative thought to devise solutions. For example, in a review of studies on innovation in the workplace, [Anderson et al. \(2004\)](#) found that such stressors as job dissatisfaction, negative mood states, unsupportive coworkers, task conflict, and home and work strain increased creativity, suggesting that stressors create a demand for creative solutions while simultaneously providing the cognitive stimulation and motivational arousal necessary for creative thinking ([Andrews and Farris, 1972](#); [Pelz, 1988](#), [Chand and Runco, 1992](#)). Zhou and Shalley (2003) identified specific dimensions of work environments that increased intrinsic motivation, and thus increased creativity in professionals. These dimensions included: challenging and complex jobs, the presence of creativity goals, and developmental (versus controlling) feedback, which [Amabile \(1996\)](#) termed environmental stimulants to creativity.

These studies demonstrate the effect of stressors as a motivating factor, activating the instinctual response to resolve cognitive dissonance and find ways to better the environment and improve the circumstances, or remove oneself from the source of the discomfort as quickly as possible. How often have you found yourself in a traffic jam, searching your memory (or apps) for ways to find a shorter, less congested route? How about realizing that a necessary ingredient for a recipe is missing while in the middle of preparing a meal, and substituting it with something on hand? In each of these examples, the stress caused by the unpleasant situation – a traffic jam or missing ingredient – generated divergent thinking which might result in a creative response.

Scholars who proposed a curvilinear relationship between stress and creativity asserted that activation theory explains how creativity is stimulated by stress only to a point; after which creativity begins to decrease ([Gardner, 1990](#)). According to this perspective, individuals are most creative at moderate levels of activation, because moderate activation levels facilitate optimal use of cognitive resources, increases task engagement, and decreases negative affect, while also increasing positive affect ([Baer and Oldham, 2006](#)). Too little or too much activation leads to a lack of engagement and cognitive interference which can diminish creative performance on cognitively demanding tasks. In addition, the effects of stressors are not the only factors to influence creativity; in the case of a curvilinear relationship, the type of stressor may also impact creative outcomes. [Byron et al. \(2010\)](#) identified social-evaluative threat and uncontrollability as possible influencing stressors that may affect different aspects of the self, which may be differentially associated with the cognitive and motivational mechanisms underlying creativity.

Social-evaluative threats can occur when an aspect of self can be judged by others, causing a decrease in creativity as a result of the increase in efforts to preserve the self. Most people have experienced classroom scenarios in elementary or high school where the teacher asked for ideas on how to solve a problem. In some cases, when a student felt confident in his or her mastery of the subject, ideas were abundant; however, when confidence of skills in the area were low, in an effort to preserve themselves, students may have experienced a decrease in divergent thinking and diminished creative ideation.

Adaptability and the Effects of Stress on Creativity From a Developmental Perspective

The three perspectives previously described address an underlying theme of adaptability. In order to be creative, one needs to be cognitively nimble, sensitive to the needs of a situation, and able to devise solutions that may need to be adjusted during any stage of solution implementation. The previous discussion focuses on examples of how stress influences creativity in the workplace; however, experiences with stress and performance emerge long before individuals become employed. Studies examining the relationship between creativity and stress from a developmental perspective suggest that the family dynamic is among the first introductions to how one must learn to adapt in order to address wants and needs. Researchers reported that stress during childhood may contribute to the development of creative skills. [Albert \(1978, as quoted in Runco, 1999\)](#) found that

the creative person to be comes from a family that is anything but harmonious—one which has built into its relationships its orientation of roles and its level of communication a good deal of tension if not disturbance, what I call wobble, but along with these characteristics, there is commitment to achieve as opposed to “having fun,” a special focus of interest and aspirations upon the child and a great deal of family effort to see that these aspirations are met.

Albert (1978, pp. 202–204)

Another type of stressor within the domain of family dynamics was identified by [Albert and Runco \(1989\)](#) who found that some parents of exceptionally gifted children are aloof, creating a distance that at first may cause stress for the child; but that may ultimately promote a sense of independence, exploration, nonconformity, and risk-taking—all hallmarks of creativity. Albert and Runco further highlight that there is an optimal amount of distance, and that autonomy and nonconformity are not characteristics that parents should maximize since it is not guaranteed that autonomy and nonconformity will result in creativity; in some instances the result is serious social and emotional disturbance.

[Winner \(1996\)](#) conducted studies with gifted youth and posited that children who experience stress may retreat into “an obsessive, solitary focus on an area of talent Hardship could teach lessons in perseverance and resilience, two ingredients needed for

later creativity" (p. 300, as quoted in [Runco, 1999](#)). Her work also emphasized that stressful experiences could serve to increase a child's comfort or willingness to be different.

Birth order raises an interesting issue in the quest to better understand the relationship between stress and creativity. Some studies concluded that firstborns suffered greater anxiety and fear of physical injury ([Helmreich and Collins, 1967](#); [Nisbet, 1968](#)). In contrast, [Eisenman \(1987\)](#) found that firstborn males were greater risk takers than their later-born peers, raising the possibility that ultimate pay off or reward may shape how stress ultimately influences creativity. [Sulloway \(1996\)](#) offered yet another perspective on birth order drawing on the work of Darwin, suggesting that siblings must compete for resources. This competition and struggle is clearly a source of stress placed squarely on each sibling to develop strategies to be in favor with their parents, or find a unique niche within the family structure. Sulloway further posited that firstborns use adaptability to adjust to the birth of their siblings relying on strategies that cannot be used by their younger siblings, simply because they do not have the same goals of aligning with their parents. Younger born siblings, instead, strive to create their own position in the family dynamic by developing strategies of their own to be different from other family members, which often results in rebellion.

The Effects of Internet Use on Perceived Stress and Creativity

The widespread use of information and communication technology (ICT) has become a part of daily life. While the use of ICT demonstrated benefits for psychological health and well-being, including the acquisition of online social capital ([Ellison et al., 2014](#)), or the support of intrinsic needs ([Reinecke et al., 2014](#)), the effects of communication load and internet multitasking are another set of stressors to be considered from a developmental perspective.

Internet users of all age groups appear to be constantly connected to a stream of online content and computer-mediated communication ([Vorderer and Kohring, 2013](#)). Young children often begin with short online games and the streaming of 11-min episodes, graduating to hours of video games and close to constant social media engagement in early adolescence. Many young people are stressed by fear of missing out and the social expectations to respond to online communication. The influence of social pressure on behavior is particularly pronounced for adolescents and young adults and has been shown to decrease in adult life ([Steinberg and Monahan, 2007](#)). The sheer mass of communication content, as well as the increasingly popular trend of combining internet use with other simultaneous activities exposed users to information overload and impaired their psychological well-being ([Misra and Stokols, 2012](#)).

In a study examining the effects of digital stress across the lifespan with participants ranging from ages 14–85, [Reinecke et al. \(2016\)](#) found that communication load resulting from sending, receiving, and checking private emails and social media messages, as well as internet multitasking were significantly related to perceived stress. In addition, the indirect effects of communication load and internet multitasking on burnout and depression and anxiety demonstrated that the potential health impairments resulting from the private ICT—strain extended to decreased levels of psychological well-being. The comparison of the three age categories (14–34, 35–49, and 50–85) suggested that older individuals were better at coping with internet multitasking than younger users, which could be explained by the process of accommodation.

As seen in prior research on aging and cognitive ability, older individuals engaged in various strategies to compensate for age-related decreases in cognitive capacity, including the avoidance of deficit-revealing situations ([Salthouse, 2012](#)). In the case of Internet multitasking, this could imply that older adult users more actively avoid situations in which multitasking exceeds their cognitive capacity by choosing concurrent activities that require low cognitive demand. Such accommodation strategies may be used less frequently with regard to communication load as users have limited control over incoming messages and the necessity to respond. Though this study did not examine creativity directly, the findings highlighted that strain from private computer-mediated communication has similar effects on psychological health and well-being as ICT-related information overload in the workplace, which parallel earlier discussions regarding the effect of cognitive demand as a stressor effecting creativity.

Summary and Conclusions

What are the implications for the connections between stress and creativity? Early in the chapter, three relationships were identified: the role of stress in decreasing creativity, increasing creativity, and that stress increases creativity to a point; with too much activation and/or social-evaluative threat causing cognitive overload, thus eventually decreasing creativity. This curvilinear relationship was found to most accurately represent the complex relationship between stress and creativity, as indicated by findings of the meta-analysis of competing theoretical models of the relationship between stressors and creativity ([Byron et al., 2010](#)). Key findings emphasized the importance of perceived stress, how stress-inducing the stressor is, and at what developmental timeframe it emerges. Tension to a degree, serves to spark creative thinking; while an excess causes cognitive overload and diminishes creative ideation. Developmental themes addressed the role of birth order in honing specific creative skills through competition, acknowledging that this tension is an important component of what motivates action. And finally, the effects of digital stress on creativity were discussed in the context of cognitive load that varies by age.

The perspectives discussed in this entry move well beyond examining the general nature of the relationship between stress and creativity to highlight inconsistent findings regarding how different stress stimuli effect creativity under varying conditions and at differing points across the lifespan. The themes discussed underscore that the relationships between stress and creativity are complex

and may not be adequately captured by merely describing them as positive or negative. Future investigations should further illuminate these relationships by exploring promising mediators and moderators to determine for whom and under what conditions stress affects creativity.

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Suicide

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Introduction

Suicide is a multifaceted public health problem of global significance. Almost 1 million people die every year from suicide which means that one person deliberately kills her/himself every 40. Throughout history, anecdotes of creative individuals, and in particular writers, being more inclined toward suicidal ideation and acts have resurfaced and reinforced a notion that creativity may be associated with increased risk of suicide. This chapter examines the current evidence underlying this notion and discusses why such an association could exist.

Suicide—Definitions and Epidemiology

Suicide is the act of a person intentionally ending one's life, whereas suicidal behavior refers to both thoughts and behaviors related to this act. These behaviors include specific measurable outcomes such as suicidal ideation, suicide plans, and suicide attempts. The difference between suicide ideation and suicidal plans is that plans include the formulation of a specific plot by which the individual plans to perform a suicide attempt. Suicide attempts require a self-injurious behavior in which there is at least some intention of dying as a result of this behavior, thus, contrasted with non-suicidal self-injury where there is no intent to die.

An investigation of 17 countries demonstrated that the lifetime occurrence of suicide ideation is 9.2%, plans 3.1%, and non-lethal attempts 2.7% (Nock et al., 2008). More recent data from 2016 in the Global Burden of Disease Study emphasize the large variability of suicide mortality across regions ranging from 4.8 per 100,000 in North Africa and Middle East to 27.5 per 100,000 in Eastern Europe. But, regardless of the considerable difference between locations in terms of the prevalence, once established the characteristics of suicidal behavior are fairly consistent across different countries. For example, the onset of suicide ideation increases dramatically during adolescence, and about a third of people with suicide ideation will go on to make a suicide attempt, and more than 60% of these attempts occur within one year of the onset of suicidal ideation.

Suicide—Risk Factors

The underlying causes of suicidal behavior remains elusive, but several risk factors have been identified. There is an increased risk for non-fatal suicidal behavior among unmarried, socially disadvantaged (e.g., low income and education, or unemployed), young people, and women. Men are more likely to die by suicide. The global male:female ratio is 1.7, which means that men complete suicide almost twice as often as women. In high-income countries this ratio is increased to 3.5 (Turecki and Brent, 2016). Certain occupational groups have also consistently been demonstrated with increased risk for suicidal behaviors. These include an increased

risk in lower skilled occupational groups (possibly symptomatic of social and economic disadvantages), and among those with easier access to means for lethal suicide such as farmers, police, military and medical professionals.

Psychopathology Is the Main Risk Factor for Suicide

One of the most researched risk factors for suicide is psychopathology (mental illness). Findings based on psychological autopsy using a combination of interviews and corroborating evidence from sources such as hospital and general practice case-notes, social work reports and criminal records, suggest that 90% of people who die of suicide have a psychiatric disorder, although a recent review stressed that there is considerable heterogeneity in different parts of the world with the prevalence of any mental disorder among suicide victims in East Asia (70%) was markedly lower than in North America (88%) and South Asia (90%).

Depressive episodes in patients suffering major depressive disorder or bipolar disorder account for at least half of suicide deaths, with a 20-fold increased risk. Suicides are completed by 5%–14% of all affected individuals with schizophrenia. There is some confusion about substance use disorders, as these are sometimes reported separated from other mental disorders, but in outpatients substance related disorders represent the second most common reason (22.4%) for completing suicide. In high-functioning (i.e., no co-existing intellectual disability) autism, a 10-fold increased risk of suicide was reported in a Swedish national sample. Studies also demonstrated a marked increased risk of suicide in eating disorders both in young adults and patients aged 25–44 years.

Is There an Association Between Suicide and Creativity?

Many famous creative individuals have committed suicide, and often stories of these individuals have served to uphold a perception of creativity as unambiguously intertwined with suffering and drama aptly captured by the writer Red Smith: "There's nothing to writing. All you do is sit down at a typewriter and just open an artery." (Abra, 2015, p. 25). Scholarly work on creativity and suicide has followed a number of themes including the meaning of suicide in art, case studies of artists who committed suicide such as Sylvia Plath and Vincent van Gogh, and increasingly using a quantitative approach targeted at both eminent individuals and those in creative occupations overall (Stack, 1996).

Researchers began to gather samples of creative and eminent individuals to understand more about the nature of geniality in the early 20th century. Ellis studied 1030 British geniuses (1904), Lange-Eichbaum (1928) sampled 800 historical geniuses, and Juda (1949) focused on artists by investigating 113 notable German artists and 181 scientists from the period 1650–1900. The common conclusion of these authors was to question earlier proposals of geniality being necessarily associated with madness as forcefully proposed by Cesare Lombroso in 1891. Juda (1949) found that 2/113 (1.8%) of the artists investigated committed suicide. Stack (1996) noted these results were similar to US data for American males in 1990 (1.76%); however, he also concluded that given the historical perspective, suicide was likely far less common in the period of Juda's investigation (1650–1900).

Ludwig (1992) investigated 1005 prominent individuals whose biographies were reviewed in the New York Time Book Review 1960–90, and found that those engaged in theatrical professions, writers of fiction and poets demonstrated comparably high rates of suicide attempts. Another study of 291 world-famous men, based on those judged to have achieved lasting international fame for their impact in a variety of fields, found five cases of completed suicide (Ernest Hemingway, Ludwig Boltzman, Vincent van Gogh, Adolf Hitler, and Pyotr Tchaikovsky), and a total of 22 suicide attempts. Writers most frequently exhibited suicidal behavior with 16% having made a suicide attempt.

Preti et al. (2001) investigated a sample of 4564 eminent artists who died in the 19th and 20th centuries. Eminence was defined as those whose achievements rendered an inclusion in an established encyclopedia for art, literature, and music. The sample consisted of 2259 poets and writers, 834 visual artists, and 1471 artists involved in musical activities. There were 63 suicides in the sample (1.3%). Literary artists stood out (2.3%), and specifically female literary artists (4.3%). Female poets were at the highest risk with 6 out of 42 (14%) committing suicide (Lester and Krysinska, 2011). Musicians and composers (0.2%) as a group had lower suicide rates than the literary and visual artists (0.7%). It was suggested that this could be due to several reasons, such as that a musical occupation generally involves more social interaction and better opportunities for employment than a literary and visual arts career. In addition, developing a skill for music requires technical skills and constant social interaction which would be difficult to acquire for individuals with severe mental disorders. Finally, the researchers proposed that the musical activity in itself could have a therapeutic effect.

Stack (1996) studied artists based on occupational data in 21 US states. The study was limited to the working-age population aged 21–64. The sample consisted of 6198 suicides and 8827 natural deaths during 1990. Artists were defined as authors; musicians and composers; actors and directors; painters, sculpturers, craft artists, artist printmakers and dancers. Results demonstrated that artists had about 125% increased risk of suicide compared to non-artists when adjusting for age, gender, and race.

Stack's findings could not be corroborated in a Swedish total population study including a sample of patients with psychiatric disorders and data on all completed suicides in Sweden 1952–2009 (Kyaga et al., 2013). Information on occupation in this study was gathered through national mandatory self-report questionnaires completed by all adult citizens in 1960, 1970, 1975, 1980, 1985, 1990 and through a national register from 2001–09. Artists as a group demonstrated no increase in completed suicides (Odds ratio 0.93 (0.86–1.01)) compared to matched controls. However, as previously suggested by Ludwig and Preti et al.

when only analyzing authors there was around a 50% increased risk of suicide. Performing artists and directors also demonstrated a significant increased risk of suicide of about 30%. In line with Preti et al. results, visual artists displayed a lower likelihood of suicide than authors, and musicians and composers even lower than matched healthy controls. Scientists had less than half the risk of suicide compared to matched controls. The reported results of this study may be conservative estimates as it only included what was considered as “certain suicides.” When also including what was labeled “uncertain suicides” the risk of suicide for authors increased to about 90% and for performing artists and directors to around 50%.

Finally, a recent report by the [British Office for National Statistics \(2017\)](#) analyzed suicides by occupation in England from 2011–15 and found an increased risk of suicides in both males (~38%) and females (~112%) working in artistic, literary and media occupations. Contrary to recent investigations, musicians were found to have the highest risk of suicide (males (~152%), females were too few to report), followed by actors, entertainers and presenters (males (~141%). Females had few cases but were reported, whereas neither male or female authors, or writers and translators had a significant increased risk of suicide. It is not clear if the latter findings were due to a broader definition of writers than previously used in other studies.

Is There an Association Between Psychopathology and Creativity?

Given that 90% of people dying by suicide have a concurrent psychiatric disorder, it is pertinent to consider if an increased risk of suicide in creative individuals is mediated by increased psychopathology in this group. Suggestions that creativity and geniality are related with eccentricity and even madness has a long history. Often referred is Aristotle's (384–322 BCE) question placed in *Problematika XXX*, written by his pupil Theophrastus (371–287 BCE), “Why is that all those who have become eminent in philosophy, politics, poetry, or the arts are clearly melancholics and some of them to such an extent as to be affected by diseases caused by the black bile?”

In 1987 Andreasen, interviewed 30 creative writers at the University of Iowa writers' workshop, and compared those to healthy controls. She found increased risk for affective disorders (depression and bipolar disorder) in general and for bipolar disorder in particular. Similarly, Jamison found increased risk for affective disorders in 47 British writers (1989). Ludwig found an increased occurrence of bipolar disorder, schizophrenia-like psychosis and depression in the creative arts group compared to general population means.

These three studies have been criticized by some authors questioning the association between creativity and psychopathology. [Schlesinger's \(2012\)](#) criticized the authors of these studies for both selecting study subjects and making the diagnoses themselves. This would render the results open to both bias and hamper generalization. While aspects of Schlesinger's criticism is relevant, she didn't mention the other roughly hundred empirical studies investigating the association between creativity and psychopathology that address many of the previous limitations.

Different Types of Creative Expressions

As has already been described, the type of creative occupation, i.e., being a writer, an actor, a visual artist, a musician, or a scientist seems to be related to the risk of suicide differently. In general, studies suggest that writers and specifically poets are most at risk for suicide. There are several reasons why this may be the case. In general, literary work is done in solitude and with lack of continuous gratification compared to performing and visual arts. The latter could also lead authors to depend more on leisure activities as a source of immediate satisfaction, which in turn could promote a less healthy life style. Similarly, as suggested by Preti and colleagues it may be more difficult to maintain employment as a writer than in other creative professions (2001) and other creative expressions such as music requiring technical skills could be difficult to acquire for individuals with severe mental disorders. This is certainly corroborated in the studies by [Kyaga et al. \(2013\)](#), where authors had an increased risk for schizophrenia, bipolar disorder, unipolar depression, and many other psychopathologies. However, musicians did have an increased risk for bipolar disorder.

In fact, studies have also suggested that different psychopathologies may be more or less prevalent pending on the creative expression. Examination of the healthy siblings of patients with schizophrenia, bipolar disorder and autism in the total population data provided by [Kyaga et al. \(2013\)](#) indicated that these disorders differ in the likelihood dependent on what type of creative expression is being investigated ([Fig. 1](#)). There was a trend toward increased occurrence of artistic professions more than scientific professions in siblings of patients with schizophrenia, and conversely scientific occupations being more pronounced in siblings to patients with bipolar disorder and autism.

Suicide—Theoretical Model

The causes of suicidal behavior are still not fully understood; however, it is clear that there is a complex interplay between different factors. Today, suicide is often considered within a diathesis-stress framework. This posits that pre-existing vulnerability factors are pronounced when activated by stressful events. The factors associated with suicide risk can broadly be categorized along three different dimensions: personality and individual differences, cognitive factors, and social factors. Some of these factors may contribute to the emergence of suicidal ideation, whereas others may increase the risk of suicidal acts.



Figure 1 Study on ~1.2 million patients indicating a trend toward increased occurrence of artistic professions more than scientific professions in healthy siblings of patients with schizophrenia, and more pronounced for scientific professions in healthy siblings to patients with bipolar disorder and autism. An odds ratio (OR) higher than 1 implies an increased occurrence compared to matched controls (Kyaga et al., 2013).

Personality and Individual Differences

Biology

Suicidal behavior runs in families. It is unlikely that this is only due to imitation, as adoption studies support concordance between biological, but not between adoptive relatives. Overall, the proportion of variance explained by additive genetics for suicidal behavior has been assessed at 30%–50%. Interestingly, suicide ideation seems to be transmitted with mood disorders and show a distinct pattern of transmission of suicidal behavior. Many authors have concluded that creativity, mood disorders and suicide run alongside in families.

Personality Traits and Attitudes

Hopelessness can be viewed as both a state (changing over time) and trait (relatively stable over time) factor. It has been defined as pessimism for the future, and is a strong predictor of important aspects of suicidal ideation and behavior (O'Connor and Nock, 2014). A 10-year prospective study of patients admitted to hospital for suicide ideation was able to predict 91% of all cases of suicide from scores on hopelessness.

Perfectionism has increasingly been identified as a risk factor both for suicidal ideation and suicide attempts. Specifically, socially prescribed perfectionism where there is a belief that other people hold unrealistic high expectations may be the most detrimental type of perfectionism and has consistently been linked to increased risk of suicide. One of the reasons for this is that it promotes social disconnection, and also interacts with other factors such as negative life events.

Impulsivity has been studied intensively as a risk factor for suicide and self-reported impulsivity is associated with suicidal ideation, suicide attempts, and suicide deaths (O'Connor and Nock, 2014). It is still considered a risk factor though it has been noted in recent studies that different definitions of impulsivity rendered paradoxical results.

There have also been several studies reaffirming that specific aspects of the big five personality dimensions may be linked to increased suicide risk. This is most evident for high levels of neuroticism and low levels of extraversion, in particular when combined. These findings fit with the diathesis-stress framework, proposing that some people are more vulnerable by being more sensitive to distress (high neuroticism) and socially disconnected (low levels of extraversion).

All of the above factors can be conceived in creative professionals. Even established artists and scientists, face a frequent risk of rejection of work that they are personally vested in (Stack, 1996). This is even more pronounced in work dependent on countless hours of solitary work where no coauthors will share the rejection, such as in literary work. It is not unreasonable that those individuals, whose work is rejected, will exhibit feelings of hopelessness. Increasingly, creative professionals also face the risk of evolving

socially prescribed perfectionism supported by ever more pervasive reviewers. Finally, a meta-analysis on the personality of artists and scientists concluded that they exhibit both introversion and impulsivity to a larger extent, and that artists were especially prone to anxiety and emotional instability. A study of creative college students also suggested that these perceived suicide as both a more normal behavior and judged it to be less of a moral evil compared to non-creative peers (Lester and Kryszyska, 2011).

Cognitive Factors

Several cognitive factors predict suicide risk. This is not least evident for cognitive rigidity, rendering the individual conceiving suicide as the only possible outcome (O'Connor and Nock, 2014). One study of 81 college students demonstrated that while ideational fluency may be positively associated with suicide ideation, problem solving flexibility is negatively correlated with suicide ideation suggesting that suicide ideation is a reaction to the tendency to see a large number of personal problems while having few adaptive solutions (Mraz and Runco, 1994). To further aggravate this tendency, Runco (1998) in his analysis of Sylvia Plath proposed that for the creative individual, with time, the more he or she has invested in creative endeavors the more he or she has to lose and thus will increasingly be less likely to remain flexible to new solutions. Cognitive rigidity remains a risk factor regardless with or without the presence of depression (O'Connor and Nock, 2014). Other factors are rumination referring to the repetitive focus on an individual's own symptoms of distress, and lack of interpersonal problem solving. Perceived stress could indeed result from poor problem solving by interpreting a situation as problematic when there is no apparent solution available (Mraz and Runco, 1994). Rigidity, rumination and lack of interpersonal problem solving are all common symptoms in persons suffering from a depressive episode. Behavioral rigidity and lack of interpersonal problem solving also remain core features of autism without depression.

Social Factors

Suicide occurs in a social context. Both social isolation and lack of social support are established risk factors for suicide (O'Connor and Nock, 2014). Suicide is rare in homogenous societies with high social cohesion, common values, and moral objections to suicide (Turecki and Brent, 2016). Increases of suicide rates among indigenous peoples correlate with social changes such as forced settlement and disruption of traditional structures. Economic crises resulting in unemployment and reductions in personal income has been correlated with suicide specifically in men. Finally, media reporting of suicide, especially if the individual who committed suicide is a celebrity and the reports of the suicide were romanticized has been associated with a rise in suicide proportional to the publicity received. This is the so called Werther effect derived from the publication of Goethe's "The Sorrows of Young Werther" in 1774, which allegedly led to young lovers committing suicide in imitation.

As previously discussed, many creative professionals face a difficult and insecure economic situation and lack of social support. In addition, it is possible that artists and maybe specifically authors are more exposed to and engage in romanticized stories of suicide. This could be one of the explanations why creative college students perceive suicide as a more normal behavior compared to their non-creative peers (Lester and Kryszyska, 2011).

Negative life events both in childhood (for example physical, sexual, and emotional abuse; family violence; and parental illness, divorce, or death) and in adulthood (for example physical or sexual abuse; death of a loved one; disasters or accidents; and exposure to war or other violence) has also been consistently linked to increased risk of suicidal behavior. Studies suggest a dose-response relationship between the number of adversities and ensuing risk of suicidal behavior. Physical and sexual abuse appears to convey the highest risk for suicidal behavior. In parallel, several authors have proposed that numerous eminent individuals faced adversities in early age (Runco, 2014, p. 46), and there is some support that traumatic events may incur increased creativity.

For example, Simonton (1994), reviewed the literature regarding an "orphanhood effect," suggesting that eminent individuals suffered early parental loss at higher rates than the average population. This effect seemed to be more pronounced in writers. Kim and colleagues proposed that for individuals with an independent self-image, rejection may amplify feelings of social disconnection and thereby increase creativity by conferring an inclination to move beyond common knowledge structures (2012). Another study of 376 participants recruited online from different countries (77% from North America, 8% from Europe, 6% from Australia or New Zealand, 4% from Asia, 2% from Africa, and 3% from other parts of the world) linked the experience of adversity with an increase in self-reported creativity (Forgeard, 2013). The findings were suggested to be mediated through both intrusive and deliberate rumination.

Psychopathology as the Main Driver for Suicide

It is certainly feasible to consider how many creative individuals' social situation could incur the main drivers for suicide (O'Connor and Nock, 2014). However, it remains evident that most suicidal patients feel that they are in a life situation with unbearable suffering and without hope for relief, but that their perceptions are often distorted by concurrent psychiatric disorders. Minor physical ailments for example can be insufferable under depression, and terrifying hallucinations may bring considerable suffering for the patient afflicted. There are arguments why primarily addressing psychopathology may be more relevant than considering psychosocial circumstances (Hegerl, 2016). First, psychological autopsy studies show that around 90% of those committing suicide have been suffering a psychiatric disorder. Second, while studies support that economic crisis induced an increase in suicide rates; it is possible that this is in fact driven by a deterioration in care for people with mental illness. This is suggested by data from 29

European countries showing that changes in suicide rates were not related to gross domestic product (GDP), unemployment rate, but to the prescription of antidepressants (Hegerl, 2016). An increase in the rate of prescription of antidepressants was associated with a decrease in suicide rates. Third, after the reunification of Germany in the 1990 there was a considerable change in society with unemployment increasing from 0% to 20%, societal values were changed, and many people with long professional careers saw their work terminated. Nevertheless, suicide rates decreased abruptly in the Eastern part of Germany. Thus, it seems that increased psychopathology may be a significant reason for increased suicidal behavior in creative individuals, and maybe more importantly lack of treatment for depressive episodes and other psychiatric disorders should remain an imperative in the prevention of suicidal behaviors.

Does Treatment for Psychopathology Affect Creativity?

There is support for many different types of interventions to prevent suicide. These include among others school, workplace, and community-based interventions (Turecki and Brent, 2016). Psychotherapeutic treatments for suicidal behavior share several common elements, such as the use of exploratory interventions to understand the reasons for the behavior and interventions to encourage positive and reduce negative behaviors. The therapist generally adopts an active attitude to reinforce problem solving skills.

Problem-solving is often viewed as an important component of creativity, but it has been described as structurally different from creativity and more concerned with the practical operations of seeking solutions to everyday issues. Denzler and Tsakos (2015) suggested that the distinction between the two constructs lie in the process and goal. Creativity is a dynamic process aiming to generate a new idea for an unknown problem. Problem solving, instead, is a rational process that seeks to develop a solution for a known problem. In fact, one study found that art students were more creative but performed less well on a problem-solving measure. While the distinction between creativity and problem solving can be challenged it remains evident that lack of problem solving flexibility is associated with suicide ideation (Mraz and Runco, 1994).

Meta-analyses of randomized controlled trials of lithium, generally used in bipolar disorder, support its protective effect against suicide. Three studies have examined lithium in relation to creativity, although only two provide clear results. Shaw et al. examined the effect of lithium on the productivity and idiosyncrasy of written associations in 22 euthymic outpatients with affective disorder (Shaw et al., 1986). Lithium discontinuation led to a significant increase in associational productivity and idiosyncrasy, while restoration of lithium dosage reversed both these effects. Nevertheless, another study interviewing 24 “manic depressive” artists observed that most ($n = 12$) reported favorable effects of lithium treatment on artistic productivity in the long run (Schou, 1979). Hence, while lithium may decrease associational productivity and idiosyncrasy, it seems that by reducing the rate of detrimental mood episodes the decreases in associational productivity and idiosyncrasy is outweighed in the long run.

Clozapine, an antipsychotic medication used in treatment-refractory schizophrenia has been demonstrated to be associated with a reduction of suicide attempts in naturalistic data compared with patients treated with other antipsychotics. Antipsychotics generally yield their effect by antagonizing dopamine D2 receptors. Thus antipsychotics have been proposed to diminish creative abilities dependent on intact dopamine transmission. To date no study has specifically investigated the effects on creativity by antipsychotics.

Do You Get Less or More Suicidal With Creative Activities?

It is poignant to consider why one should commit to an artistic profession in the first place given the described association to both psychopathology and increased risk of suicide. Clearly, there are many benefits from engaging in creative activities. In general, the beneficial aspects of creativity have been linked to self-actualization. Maslow saw creative expression as inseparable from psychological health, and Rogers suggested that it provides a deeply satisfying feeling to commit to creative activities. A phenomenological study of 11 artists emphasized that engaging in creative activities involved a highly energizing effect of sensing a synthesis of disparate elements, and the feeling of connecting with a deeper, more universal self. It has even been proposed that it is beneficial to work with creative writing and poetry in suicidal clients (Lester and Krynska, 2011), but this remains to be further researched. Nevertheless, art therapy has gained some empirical support as an addition to standard treatment in, for example, schizophrenia, where it has been suggested to be beneficial in addressing otherwise difficult to treat negative symptoms, such as lack of motivation and drive.

Conclusion

This entry examined the evidence underlying a notion of creativity being linked to psychopathology and an increased risk of suicide. It is argued that occupational data support an increased risk of suicide for artists generally, and for authors specifically. Most artists do not commit suicide, and creativity entails many positive benefits that promote better psychological health. Nevertheless, the social situation many artists face may be challenging and there is evidence of an increased prevalence of specific types of psychopathology, such as bipolar disorder, in people with creative professions. These findings highlight the need to provide appropriate support to individuals in need and to commit societal resources in preventive measures to reduce suicidal behavior. Today it remains out of balance considering the size of this challenge.

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Surprise

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Introduction

Surprise is a feeling one may experience while reading a novel written by Stephen King, when watching a movie directed by Quentin Tarantino, or when hearing about Stephen Hawking's theory of the universe. Surprise arises when people encounter something unpredictable, unexpected, or unanticipated, all of which then leads to wonder, astonishment, and amazement. Clearly, the unpredictable, unexpected, and unanticipated are associated with creative thinking. Surprise is embedded in the concept of creativity and manifested either as the feeling the audience for creative ideas or products experience or what painters, composers, or authors seek in their creative production. Hence, understanding surprise can contribute to the understanding and assessment of creativity.

Neural Response to Surprise

What happens inside our brains when we encounter novel and unexpected stimuli? Although surprise is considered an emotive state, it has a cognitive aspect that defines surprise as a temporal-based cognitive process of the unexpected, a violation of a belief, or a reaction to a mismatch. Some researchers in neurophysiology study surprise by showing the specific reactions of the brain to unexpected events. For instance, Schomaker and Meeter (2015) cited a variety of sources indicating that strong neural firing and activity are seen when individuals encounter unfamiliar stimuli. Some areas, including the limbic regions; frontal cortex; and temporal, parietal, and occipital areas are activated during the state of surprise. In their 2015 book, *"Surprise: Embrace the Unpredictable and Engineer the Unexpected"*, Tania Luna and Leeann Renninger stated that a "surprise sequence" occurs in the brain during the moment of surprise. The neurological system is alerted and focuses on the moment. This first reaction is followed by a cognitive effort to figure out the unexpected stimuli. Finally, in some cases, surprise forces changing one's personal perspectives: imagine you have found a new recipe positively surprising with an ingredient you normally do not like, which in turn changes your perspective about that ingredient.

Surprise process in brain have been the subject of experimental studies. In an early study, Wulf-Uwe Meyer et al. (1997) conducted an experiment to explain the mental process and sequence that occur during the event of surprise. Interestingly, they showed that a cognitive evaluation of an event that exceeds an amazement threshold value is the first step of the mental process. This ongoing process occurs through the breaking off of personal experience and information in memory and distributing resources to the unexpected event. The last step is to undertake the analysis and evaluation of the event and develop an immediate response and belief revision. Their study implies that surprise facilitates the stimulation of adaptive actions to surprising events and developing predictive and useful reactions in case the person experiences the same thing in the future.

Schomaker and Meeter also pointed out that unexpectedness could manifest in different forms, and the brain shows varied reactions depending on the form of unexpectedness. Although it is relatively less common, people may experience something never encountered before, thus feeling highly surprised, such as a first reaction to virtual reality or seeing an unusual art piece. Surprise also occurs depending on certain contextual factors. Seeing a sculpture in a museum is a common experience, but an underwater museum exhibiting sculptures is surprising even though the concept of "museum" and "sculpture" are familiar for most. Next, regardless of the stimuli, the same thing could lead to two different experiences in two different environments. An identical meal could be perceived as more or less delicious or more or less novel in different environments, such as a restaurant and a state park (the latter could be more surprising to an individual). Lastly, deviance among a group of known stimuli might be perceived as surprising. For instance, a dog picture in a series of cat pictures could make someone surprised. Interestingly, brain imaging studies indicate that different parts of the brain are activated under different surprise condition.

Emotions and Creativity

Emotions are likely to take part in creative activities. In other words, the creative process is not purely cognitive; it both influences and is influenced by emotional states. Surprise is inherently part of the creative process. When considering the definition of surprise, there is an association between the level of surprise and creativity that more a creative product is, the more people feel surprised. Emotions are part of the process of the assessment of creativity such that surprise and related emotional reactions determine the degree to which a creative product is deemed novel, unusual, and unexpected.

Both positive and negative feelings, such as happiness, enjoyment, surprise, sadness, anger, and fear, play an important role in creativity. Research studies on eminent creativity have indicated that a considerable amount of eminent artists displayed affective disorders. Hence, the “mad-genius hypothesis”, concerning whether psychopathology is correlated with creativity, is still a continuing controversy in creativity research. Apparently, a good amount of exploratory work supports the association between creativity and negative emotions. Especially regarding the “dark side of creativity”, it is more obvious that negative emotions motivate people to use their creative potential for nefarious purposes. Despite the extended literature on the issue, the “mad-genius hypothesis” is highly questionable, and currently a paradigm shift considers creativity as a type of healthy behavior rather than a deviant one associated with mental and emotional disorders. It is also not surprising that positive emotions facilitate mindfulness, breadth, and flexible thinking.

In the context of creativity, surprise can be described as the emotive moment when people engage in creativity. Amazement, surprise, and excitement are some of the emotions that arise in cases of unexpectedness. Margaret Boden (2007) addressed the issue and indicated that such emotions are a visible aspect of the creative process beyond the cognitive part. In fact, creators experience a variety of emotions during the creative process. Surprise, satisfaction, enjoyment, and happiness are some of the feelings experienced by an artist when coming up with a creative idea or seeing the reactions of people for their creative products.

Beyond being the result of creative ideas and expression, surprise itself may foster creativity. In a recent study, Malgorzata Godowska et al. (2014) examined the influence of surprise on creativity. More specifically, they proposed the concept of the “need for structure”, positing that some people may prefer a structured world and following explicit and well-defined rules, whereas others might be more flexible and tolerant of ambiguity and unexpected events. A series of pictures was presented to the participants, who were asked to study them for a following memory test. The pictures were in two different formats, with consistent vs. inconsistent content, such as an Eskimo on a desert, an astronaut on a beach, or a football player on an ice rink for inconsistent examples. Then, the participants were asked to complete a divergent thinking test that asked them to create new names for a pasta. In a second study, the same procedure was repeated with a different series of pictures, and the participants were asked to complete a Remote Association Test (RAT). Presenting consistent pictures did not make any difference in the participants’ creative performance. For the group with inconsistent pictures, however, the participants with a low “need for structure” were remarkably more fluent in their responses and similarly performed better on the RAT. The results suggested that when individuals who are flexible and tolerant to ambiguity are exposed to surprising concepts, they are more likely to think in a divergent way.

Novelty and Surprise

Creativity comes with surprise, and novelty and surprise are highly related concepts. Although there is some disagreement among researchers about the definition of creativity, novelty has been cited as one of the defining characteristics of creativity. It refers to any kind of creative response that deviates from the conventional and expected one. Novelty may be manifested in a range from slight deviation to a breakthrough in science or the arts. Although the term “unexpected novelty” has been used in creativity literature to refer to surprise, they differ slightly. Novelty refers to the degree a creative work is new or different from an existing one in a particular domain. Surprise, on the other hand, is more about the violation of expectations; thus, it is more personal and subjective.

Surprise also differs from novelty in regard to its underlying mechanism. Surprise is a temporal process that relies on cognitive schemas and memory. Schemas are the building blocks of our memory, and any violation of existing schemas or expected output in a given situation leads to surprise. Novelty, however, is relatively independent from personal expectations. Novel ideas or products lead to surprise in most cases, but the opposite is not true for many situations. The novelty in Picasso’s cubist art or the architectural design of Utzon’s Sydney Opera House is surprising for many people, whereas a “surprise birthday” party in the classic sense of a cake, candles, and prizes, while perhaps surprising for the birthday boy/girl, is highly questionable as a creative act. From a different perspective, flying cars have been expected for a long time, but despite being an expected invention, such machines are still highly novel.

Creativity and Different Types of Surprise

Surprise can take many forms depending on the form of creativity manifested. For instance, Boden (2004) defined three types of surprise. First, people may be surprised by a new idea, product, or situation that is statistically unusual and contrary to common expectations, such as a high school student earning a college degree upon high school graduation. Second, surprise occurs when people have not seen an idea as a possibility. A human being setting foot on the moon was just a fantasy for

a long time and was highly surprising when finally achieved in 1969. Lastly, people are surprised by an idea that has been considered as impossible and still seen as counterintuitive, such as wireless chargers, augmented reality, or motion-controlled electronic systems.

Corresponding to these three kinds of surprise, Boden (2004) also identified three types of creativity. Combinational creativity, for instance, arises from the unusual combination of relatively known ideas and is associated with the first type of surprise covering statistically unusual ideas. Visual collages, different types of analogies, and unexpected juxtapositions of ideas found in political cartoons are some of the everyday examples of combinational creativity that lead to surprise. Similarly, exploratory creativity uses available knowledge to generate novel ideas, but instead of just combining two known ideas, it goes beyond existing structures and displays new and valuable possibilities, which may lead to even greater surprise and excitement. Exploratory creativity does not have to be a matter of adopting something without thinking. It may include thoughtful exploration and the testing of specific stylistic boundaries, which explains why exploratory creativity plays a central role in the lives of artists and scientists. Boden further pointed out that exploratory creativity usually comes with surprise. It is not only because people are surprised when discovering a new idea but also the fact that how this profound idea was previously unseen.

Lastly, transformational creativity is the type that generates the highest surprise, amazement, and incomprehension. It refers to changing the rules or the conceptual space, allowing for the generation of something new that was previously impossible. Exploratory creativity is often associated with ordinary research processes that seek solutions for everyday problems, whereas transformational creativity is seen as those major breakthroughs that redefine our perception, experience, and understanding of problems, research fields, or the arts. Picasso's cubist style and the canvas of *Les Femmes d'Alger* was a transformational landmark. It is not surprising that creative products emerging through transformational creativity lead to personal experiences like seeing the unseen or experiencing the unexperienced.

Similarly, Bruner (1962) presented three types of effective surprise as predictive, formal, and metaphorical effectiveness. Predictive effectiveness refers to surprises arising through relatively predicted events, such as reformulation or reconceptualization, a known phenomenon in science. Formal effectiveness occurs when one sees a connection or relationship never found before or re-organizing things in an unusual way. Finally, metaphorical effectiveness refers to the combination of seemingly unrelated things such that these connections form art. In general, it is the experience that combines known things in an unexpected but effective way and surprises the audience.

Definition of Creativity and Surprise

Although there is no universal definition of creativity, originality and effectiveness are commonly considered defining characteristics of creativity. Originality refers to novelty, being new, unusual, and unique. Since it is not concerned with usefulness or effectiveness, originality is necessary but not sufficient in itself to define creativity. For instance, using a shoe as a saucepan may sound highly original, but it is neither useful nor effective for cooking purpose; thus it should be not be considered as creative. Beyond being original, creative ideas and products should be effective, serving a specific purpose or fitting a given problem condition. While a variety of relevant terms, such as usefulness, value, and appropriateness, have been cited in the literature for this second criterion, a two dimensional approach – originality and effectiveness – is commonly used for the definition and assessment of creativity.

The two-criterion view has been embraced by many researchers and practitioners; however, there has been an effort to extend the common two-criterion view to a three-criterion approach. The new approach provides a viable way to understand creativity and differentiates the creative process from other cognitive processes that lead to ordinary improvements. In his seminal 1962 paper, "The Conditions for Creativity", Jerome Bruner defined creativity as "*an act that produces effective surprise*". His approach suggests that regardless of the domains or different forms that creativity manifested itself, the creative process should end up with an effective surprise. Beyond the classic view of surprise and unexpectedness, Bruner pointed out that effective surprise requires that a creative product should be related to one's interests, personal life or experiences. Thus, people may not react to novelty with which they feel no connection. More recently, Boden also included surprise in her definition of creativity that creativity is an ability to come up with an idea or product that is new, valuable, and surprising.

Interestingly, surprise is considered an essential criterion of creative production in patent applications. Based on the US Patent and Trademark Office's description, an invention should be novel, useful, and nonobvious, which could be translated as surprise, in order to be granted patent rights. A patent application might be rejected "*if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.*" A person with ordinary skills could be considered as someone with domain-specific expertise. If a new invention can be re-created by a person of ordinary skill, it indicates that the new invention is but a predictable or expected variation of the present version. For instance, imagine that a patent is granted for ice cream waffle cones; then, a new patent application is submitted for a waffle cone used for a different food, such as salad or fruit. For evaluation purposes, using waffles cones with different foods is an obvious and predictable improvement; thus, overall, it is not considered creative and should receive rejection for a patent application.

Based on US Patent Office's criteria of creativity, Dean Keith Simonton (2012) proposed a new definition of creativity with three criteria: novelty, utility, and surprise. Simonton argued that including surprise as a new criterion leads to four implications for creativity: limitations based on domain-specific expertise, varieties of comparable creativities, subjective versus objective

evaluation, and lastly, blind variation and selective retention in the creative process. More specifically, since the person with domain expertise plays an important role in evaluation of surprise, the three-criterion definition leads to limitations determining creative products that are highly sophisticated and interdisciplinary. Secondly, the new definition allows greater variance and flexibility in the assessment of creativity. Third, the new definition provides both subjective and objective aspects in the evaluation of creativity that includes creators' subjective experiences and evaluators' objective expertise and assessment. Finally, extending two-criterion definition with surprise supports the idea that blind variation and selective retention play an essential role in the creative process.

Although surprise as a separate dimension of creativity was introduced by Bruner in 1962, today it is still regarded as a novelty-related term by many researchers. The aforementioned novelty-surprise distinction may need further theoretical and empirical studies to recognize surprise as a distinct defining characteristic of creativity. Nevertheless, including surprise in definition of creativity can certainly contribute to understanding, assessment, and application of creativity in a broader sense. Obviously, surprise is a fundamental characteristic of novel products and an emotional reaction to creative production, thus, to some degree, any definition of creativity should give weight to the idea of surprise as a defining characteristic of creativity.

Eureka, Aha Moments, and Insight A eureka moment, called "aha" experience, and insight are related concepts that lead to surprise. The Merriam-Webster Dictionary defines the eureka or aha moment as "*a moment of sudden realization, inspiration, insight, recognition, or comprehension.*" It is the moment when the brain figures out the solution for a problem that it has been dealing for a while. It is an unconscious process called as incubation that occurs from the culmination of previous work. It is one of the stages proposed by Graham Wallas (1926) in his theory of the creative process. Wallas explained the creative process in four stages as preparation, incubation, illumination, and verification. Preparation is the stage of identifying a problem and gathering information about it. Incubation is the stage when people come up with creative ideas and solutions after taking a break from struggling with a problem. What happens in our brains or where those eureka moments come from is still a mystery to some degree. One explanation is that incubation allows the mind to wander and temporary changes the focus of attention from the problem, thereby cultivating opportunities for creative insights. Neuroscience reveals that different parts of the brain are activated during insight experiences. For instance, people who use insight for problem solving exhibit greater right parietal activity, associated with high attention and less control. By contrast, people who use analytical thinking experience higher left frontal activity that fosters more control and organization of thoughts. Regardless of the source of insight, many studies in the literature indicate that incubation is commonly experienced by many people in a variety of fields. It is surprising that some of the most influential ideas have arisen through creative insights. The eureka moment Sir Isaac Newton experienced is maybe the most famous. He saw an apple falls from a tree and became fascinated with the idea that all apples fall perpendicularly toward the earth. This experience led him to discover the law of gravity. Similarly, Archimedes discovered the Archimedes Principle while taking a bath. He was so excited and even rushed home naked, yelling, "Eureka! Eureka!" meaning "I've found it! I've found it!" in Greek. The invention of penicillin, the microwave, popsicles, Play-Doh, and many other discoveries have similar stories. Moreover, insights and eureka moments are not limited to scientists or artists that many people experience creative insights and aha moments in their daily lives at some level and feel surprised when a creative solution pops up in their minds.

Violation of Expectation The violation of expectation is the underlying mechanism of surprise such that any unexpected behavior or stimuli leads to the emotion of surprise for observers. Expectations are part of the learning process in children's development. Children are full of surprise and highly creative in their behaviors, expressions, and art forms during childhood. However, they gradually become more aware of conventional norms, appropriate behaviors, and expectations, which in turn lead to losing creativity as they grow up. The fourth grade slump, referring to the significant decline in children's creativity at this time, is a well-known phenomenon indicating that children lose their creativity as they become developmentally and cognitively mature and more concerned with expectations.

Frank Lachmann (2006) proposed that creativity and perversion are based on the violation of expectations. He stated that the violation of expectations is a motivational factor for creativity, and such violations lead to surprise and shock for observers. In his study, Lachmann elaborated on Marc Chagall and Richard Wagner and how violation of expectations played an important role in their creativity. Both artists were physically weak at birth, and their parents did not expect them to survive. They first violated expectations through their physical development: later, Chagall in his paintings and Wagner in the realm of opera designed their arts in such a way as to violate common designs and expectations. They were considered as the contrarians of their time. Contrarian people think in a way that significantly differs from the mainstream, thus violating expectations and causing surprise in other people. In an experimental design, Ritter et al. (2014) investigated the role of the violation of expectations, called schema violations, in fostering cognitive flexibility, an essential mental ability in creative thinking. In a 2×2 group design, they presented a video showing the preparation of a sandwich in a regular way, while for the second group, the chef followed a completely odd sequence in its preparation. For the second group, some of the participants were also asked to imagine themselves as the chef in the video. In a second study, a similar research design was repeated and the participants' brain activity was observed with functional Magnetic Resonance Imaging (fMRI). The results of the study indicated that those who assumed the role of the chef in the violated scheme shown in the video showed greater cognitive flexibility and brain activity in their temporal parietal junction (TPJ). This implies that without any physical involvement, cognitive flexibility may be improved through exposure to a stimulus that violates personal expectations. It should be noted that most creative ideas and productions are subject to violation of expectation, but not all violations of expectations or cases of contrarianism lead to creativity. Some people can go against the crowd just to be able to attract attention or build an identity or self-image around contrarianism. These could well be signs of creativity, but it is not necessarily true that all weird behaviors or expression should be considered as creative acts.

Adapters Versus Innovators

Clearly, the creative process and products are highly related to surprise, but a creative person is also an important factor in understanding creativity and the creativity-surprise connection. It is a common experience to have friends full of surprise and others who behave relatively in an expected way, thus not surprising. The question is what makes someone more likely to surprise others or lead to amazement? Michael Kirton's (1976) Adaption-Innovation Theory provides a framework to understand the relationship between different styles of creativity, creative persons, and surprise. Kirton's theory described two different creativity styles, namely, adaption and innovation, or adaptors and innovators in a personal context. While adaptors focus on innovation and "doing things differently," adaptors are more concerned about improvements or "doing things better." They differ in their personal characteristics in that innovators are considered to be associated with extraversion, risk-taking, flexibility, tolerance to ambiguity, a lower need of structure, and openness to experience. Kirton himself described innovators as seemingly undisciplined, having unusual perspectives on tasks, capable of a detailed task in a short time, seeking extraordinary change, and showing high self-efficacy in idea generation. Adaptors, on the other hand, are more likely to follow conventional thinking, be more comfortable with the status quo, and needing a more structured environment and working procedure. In Kirton's description, adaptors are more concerned with problem solving rather than problem finding. They use an existing framework and structure to solve problems, show a high performance in detailed tasks, rarely challenge the status quo, and care more about others or group harmony. The characteristic differences between innovators and adaptors do not necessarily indicate the latter are not creative. Instead, the theory suggests that adaptors prefer different manifestation of creativity within a given framework, while innovators are more open to new possibilities. Based on these descriptions, it should not be surprising that adaptors are more likely to generate combinational or predictive creativity and innovators to produce transformational and metaphorical creativity as discussed above. It may be expected that innovators will lead to greater surprise in their career professions and possibly in their personal life and relationships. Since adaptors are less likely to challenge group rules or conventions, they may not display unexpected behaviors and surprise other people, both in their work and personal lives.

Conclusion

Surprise is an emotional reaction to unexpected stimuli, and several conclusions may be drawn regarding the creativity-surprise connection. Some parts of the brain associated with creativity are more activate during the experience of surprise. Next, surprise is inherently experienced when someone encounters a novel idea, production, or creative insight; thus, it is an essential part of the creative process. Additionally, there is a growing body of literature suggesting that surprise is a defining characteristic of creativity and should be involved in the definition of creativity as a third criterion. Finally, promising research efforts now show that beyond being the result of the creative process, surprise, more specifically the violation of expectations, can boost creative expression and production.

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Systems Theories and Approaches

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Arriving at a more complete understanding of creativity requires that it be studied at multiple levels of analysis. Over the 60-plus years since it was charted as a research domain, creativity scholarship has largely centered on examining the psychological attributes and processes within the individual. Since the mid-1980s, however, systems approaches have emerged as important lenses for understanding creativity as situated within broader contexts. All systems approaches share theoretical principles and, to some extent, vocabulary and foundational bases for research methodologies. As characterized by Kozbelt et al. (2010), "Some of the broadest and most ambitious theories of creativity take the view that creativity is best conceptualized not as a single entity, but as emerging from a complex system with interacting subcomponents—all which must be taken into account for a rich, meaningful, and valid understanding of creativity" (p. 38).

Systems Thinking

Bunge, whom Pickel (2011) describes as one of the most eloquent and incisive advocates for the systems philosophy, describes a system as "a complex object [entity] whose parts or components are held together by a bond of some kind. These bonds are logical in the case of a conceptual system, such as a theory; they are material in the case of a concrete system, such as an atom, cell, immune system, family, or hospital. The collection of all such relations among a system's constituents is its structure (or organization, or architecture)" (Bunge, 2004, p. 188). While conceiving the universe as comprised of systems is not original to the 20th and 21st centuries, the concept gained significant traction in the mid-20th century. Ludwig von Bertalanffy proposed, expanded, and revised his theory over several decades, culminating in his capstone work *General System Theory: Foundations, Development, Applications* (1968). His title's use of the singular "system" theory, instead of the much more prevalent "systems," conveys his formidable quest for one unified theory that would transcend all disciplines. By the time of his volume's publication, however, his view no longer held currency among scientists. His attempt to "transcend analytical philosophy of science" was not successful and his goal seemed well beyond the reach of the social sciences. The theory was deemed too vague, unwieldy, and not testable.

We cannot, however, diminish the influence of such early forerunners on contemporary systems approaches. Early systems thinking codified a vocabulary and concepts that are now part of our cultural consciousness. The idea of a system as components held together by a bond is now conventional wisdom. We do not see as alien the central tenet of "holism" (that a phenomenon is not due to any single cause, but to a network of interacting parts). The idea that "open systems" interact with their environments and that "closed systems" do not is also now understood intuitively. Many of the sciences share a grammar in the analysis and discussion of life represented by such terms as "equifinality" (that the same goal can be achieved through different paths); "isomorphism" (that structural, behavioral, and developmental features and laws are shared across systems); and "emergence" (that novel properties arise as evolving organisms seek higher levels of complexity). "Positive feedback," "negative feedback," and "feedback loops" are now terms fundamental to the biological, physical, and social sciences.

New Systems Thinking

Following a largely fallow period that began in the late 1960s, systems theories, for the last 30 years, have been experiencing a renaissance. Pickel (2011) refers to this collection of approaches as “new systems.” Bunge (2004) uses the terms “systemism” and “systemic approach” to represent such contemporary approaches as, but not limited to, nonlinear dynamical systems theory (i.e., chaos theory), dynamic systems theory, autopoietic (self-organizing) systems theory, and complexity theory. Although robust progeny of the systems thinking of the 20th century, these newer theories share core principles significantly reformulated from General Systems Theory (Pickel, 2011). Newer systems approaches are not a vague kind of holism (Poutanen, 2013), a common criticism of the Bertalanffian view. These new approaches emphasize analysis as much as synthesis. Central to these theories is the principle of emergence, the process by which novel properties arise—when components of lower complexity are combined in novel ways.

Unlike their predecessors, the newer approaches recognize the necessity of describing the mechanisms underlying a system. The processes might not follow linear, causal laws; they can be nonlinear and cyclic, arising from the interconnected nature of the system and multiple feedback loops (Montuori, 2011), but a mechanism-based explanation is essential for a theory to have an ontology and methodology that is taken seriously (Bunge, 2004). Of the new systems approaches, Poutanen (2013) contends that complexity theory, in particular, may have the strongest power to illuminate general mechanisms. These newer approaches have been applied in linguistics, cultural studies, psychology, economics, ecology, neuroscience, sociology, history, organization studies, political economy, global studies, engineering, sociology, computer science, mathematics, ecology, human development, art, the humanities, and education.

Systems Approaches to Creativity Research

While General Systems Theory failed to meet its ambitious goal of providing a unified, transdisciplinary theory, it did create a seedbed for scholars to think in terms of systems—including in application to creativity. The first two waves of creativity research focused on the individual: the personality psychology approach in the 1950s and 1960s and the cognitive psychology approach, which began in the 1970s and continues to the present. With Amabile's *The Social Psychology of Creativity* (1983) and her subsequent *Creativity in Context* (1996), the argument for a sociocultural approach was established. Amabile posited that creativity happens within contexts, within environments that have significant influence on both the creative process and the creative product. Simon-ton, as well, was early on the scene, offering vast collections of data and comprehensive explanations of the larger environment's role in shaping creativity (Simonton, 2014).

In the study of creativity since the mid-1980s, many systems approaches have emerged. Following is a brief, noncomprehensive discussion of several. Some do not use the term “systems,” but nonetheless implicitly share systems principles. Because of its impact and prominence, Csikszentmihalyi's Systems Model of Creativity (Csikszentmihalyi, 1988), also referred to as the DFI Model, will be discussed in detail.

Csikszentmihalyi's Systems Model of Creativity

By the mid-1980s, Mihaly Csikszentmihalyi had been engaged in the serious study of creativity for over 20 years, dating back to his dissertation research studying the creative processes of young artists. As a new scholar, he assumed, as was the custom among those studying creativity during those early years, that creativity consisted of the traits/abilities/talents/skills that resided within the person.

As Csikszentmihalyi has reported (1988; 2014a), he became less certain of the widely shared assumption about the locus of creativity. His skepticism was sparked when contemplating results of the longitudinal study of artists conducted with his PhD advisor, Jacob Getzels, in which they had discovered evidence that the creative ability (perceived by expert judges) of young artists was not a predictor of those artists' success years down the road. In fact, following the artists over time, they observed that the larger sociocultural environment, especially in the cases of female and black artists, had a significant bearing on later success. And, adding to their surprise, many of those deemed less creative when younger were more successful in their later contributions as artists because of the opportunities and resources afforded by their environments. Neither talent, nor cognitive, emotional, and motivational processes appeared to be the most influential factors in participants' artistic achievement.

Looking for creativity in the psyche of the individual could never lead to a full understanding of the phenomenon because the individual was only part of a larger phenomenon. Unveiled in 1988, Csikszentmihalyi's Systems Model of Creativity is the dominant explanation for how creative contributions make an impact upon a domain and change the culture. Applying the distinction usually attributed to Stein, this model intends only to explain Big C, eminently creative accomplishments, rather than small c, everyday creativity. Big C creativity propels the culture and our species forward. It is a level of creativity that is rare, that produces a consequential impact, and that, as a result of some form of adjudication, is socially valued, certifying that the novel idea or product is better or more useful than its predecessor. The Systems Model (see Fig. 1) illustrates that creativity is not a set of individual attributes, but that creativity, and ultimately creative contributions, happens within a larger sociocultural system of which the person is an important component, but not the only one.

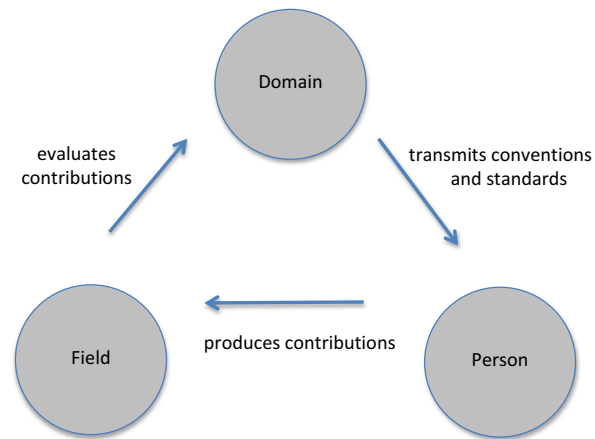


Figure 1 Systems Model of Creativity.

The Domain

All societies produce a culture, the system of learned rules that regulate to various degrees its people's thoughts, beliefs, and behavior. Culture organizes those rules into domains. Mathematics, education, government, transportation, childcare, and art are but an infinitesimal sampling of the thousands of explicitly organized domains in our culture. Domains, furthermore, are comprised of subdomains: number theory is a subdomain of mathematics, evolutionary biology a subdomain of biological science, and animation a subdomain of art. Over time, each domain and subdomain have developed boundaries and rules that define which processes, norms, procedures, and beliefs are appropriate. By nature, many domains are self-protective, conservative, determined to protect their very existence. They evolve slowly, sometimes only reluctantly, if ever, welcoming new ideas and innovations. Some domains, however, are much more relaxed, freely admitting new ideas and change.

For 300 years, the domain of science was fiercely protective of the Cartesian and Newtonian paradigms. Those perspectives on the universe and the companion method for conducting science were not open to change because the domain was convinced that these paradigms described the Truth. However, in part due to systems thinking and new conceptions of physics, the domain of the physical sciences did ultimately evolve, and quite rapidly, in the face of new, undeniable evidence about the Universe.

The Person

Most people find acceptable the rules, procedures, and norms that domains and subdomains have transmitted through their formal and informal education and through life experience. They will follow the conventions they're expected to without questioning their assumptions. Most, for example, won't ponder whether or not the conventional explanation of Time is correct. Some, however, because of genetics, personality, motivation, and factors not yet understood or even identified, will come to believe they can improve an existing domain. Doing so, however, almost always requires that the Person have expertise. Those wanting to make creative contributions usually find that there are far more persons like them with novel ideas and innovations than the culture can possibly pay attention to. The number of artists, actors, and authors far exceeds the number of galleries, roles, and publishers available to advance them. Relatively few persons successfully change a domain—even fewer gain the momentum of additional contributions and build a canon of creative work.

The scientific revolution of the early 20th century happened, in part, because pioneers such as physicists Werner Heisenberg, Albert Einstein, and Niels Bohr were instrumental in the development of quantum physics. The talent, curiosity, personality traits, and cognitive abilities of these Persons prohibited them from accepting the Domain of physics as it existed.

The Field

How do ideas and innovations make their way from the Person to a Domain? Most ideas will not improve the Domain and some will likely make things worse. It is the role of the Field, which sometimes consists of society more broadly, to screen potentially creative contributions to a Domain. "Field" as used here does not refer to a discipline or area of expertise, which is more closely related to the concept represented by the term "Domain." Consistent with the perspective of most creativity scholars, the Systems Model presumes that a product's creativity requires adjudication. It must be seen as having value by the Field, the gatekeepers to the Domain. Within the world of fine art, the Field in part is comprised of critics, gallery owners, and collectors. In the sciences, major creative contributions occur because the gatekeepers (journal reviewers, academic peers with sophisticated expertise, foundations that provide research funding) validate new ways of thinking and engaging in science. Csikszentmihalyi (2014a) argues, "If all it takes to be creative is for a person to believe in their own creativity, then everybody is creative, and the term is synonymous for 'human being'" (p. 540). Novices are unlikely to produce the kind of novelty that will be reviewed favorably by gatekeepers.

The Systems Model is not without limitations and criticism. Kozbelt et al. (2010) are generally positive in their assessment, citing its importance for bringing attention to sociocultural influences on creativity. The model's application over multiple levels of

analysis can create methodological challenges, but they acknowledge that this seems an acceptable tradeoff. Their most serious concern is that the model's qualitative nature "may make it more difficult to test hypotheses unambiguously" (p. 40). Weisberg is more critical, taking issue with Csikszentmihalyi's insistence that a product's social acceptance is necessary for it to be deemed creative. Instead, Runco et al. (2010) take exception to a related issue: the model's assumption (intellectually consistent with the rest of the model) that an individual's creativity can change over time (Csikszentmihalyi, 2014a). The model is used to support the argument that if the culture and a Domain are hospitable to the Person's idea or product, he or she is considered creative. However, if the Person's contribution is no longer supported by the Domain after death, in keeping with the Model, the Person would no longer be considered creative.

Applications of the Systems Model

The Systems Model has influenced a significant body of theoretical and empirical scholarship represented by the following synopses.

Nakamura and Csikszentmihalyi (2003; reprinted in Csikszentmihalyi, 2014b) offered the Systems Model as a lens for viewing creativity in the lives of eminently creative persons whose achievements had traditionally been explained through conventional, deficit-based models. The authors integrated Bloand's deficit-based analysis of her father Erik Erikson's pursuit of fame with a strengths perspective. They apply the Model as a framework to explain Erikson's investment of attention in his creative achievements as a psychologist. Csikszentmihalyi and Nakamura (2006; reprinted in Csikszentmihalyi, 2014b) have also employed the Systems Model in an argument for viewing human aging from an evolutionary perspective. The exploratory behavior that undergirds creativity into the last years of life, they argue and support with exemplars, is contingent upon the Domain of the person's work, as well as the opportunities and obstacles of the Field, both critical for sustaining curiosity, interest, and passion. The Systems Model can serve as a framework for positive aging, as well as a tool for researchers seeking to explain the role of aging in the lives of study participants.

Perhaps a natural extension of the model is its application beyond explaining individual creativity, to providing a framework and vocabulary that organizations can apply to create environments that are high-functioning and innovative. Csikszentmihalyi and Sawyer (1995; reprinted in Csikszentmihalyi, 2014b) make the case that organizations desiring to increase creativity and innovation should cease their inordinate focus on individual creativity and, instead, focus on using the Systems Model as a basis for developing organizational creativity. Csikszentmihalyi and Wolfe (2000; reprinted in Csikszentmihalyi, 2014b), in "New Conceptions and Research Approaches to Creativity: Implication of a Systems Perspective for Creativity in Education," argue for the model's utility in developing learning environments that will result in increased creativity in schools.

Several publications by Csikszentmihalyi and collaborators report on studies for which the Systems Model has served as a theoretical foundation and, in some cases, has shaped study design, data collection, analysis, and interpretation. Drawing from interviews with eminently creative persons collected in the Creativity in Later Life Study (Csikszentmihalyi, 1996), Csikszentmihalyi and Sawyer (1995; reprinted in Csikszentmihalyi, 2014b) explore the relationship between an individual's insights and his or her facility for accessing the Field and contributing to a Domain. Drawing from the same dataset, Mockros and Csikszentmihalyi (2014; reprinted in Csikszentmihalyi, 2014b) examine the influence of Fields and Domains on historical, educational, professional, and cultural systems, particularly the ways culture contributes to the absence of creative women in specific domains. In "Catalytic Creativity: The Case of Linus Pauling," Csikszentmihalyi and Nakamura (2001; reprinted in Csikszentmihalyi, 2014b) marshal evidence for the significant role of the Field in mediating meaningful interactions between the Person and the Domain over a career. Integrating systems thinking and Bourdieu's concept of Social Capital, Hooker, Nakamura, and Csikszentmihalyi (2003; reprinted in Csikszentmihalyi, 2014b) report on a study of university student apprentices in a space science lab and make several recommendations for optimizing mentoring conditions. In their historical analysis of painters and painting, Abuhamdeh and Csikszentmihalyi (2014; reprinted in Csikszentmihalyi, 2014b) use the Systems Model to build a case for the personality of artists as dependent upon the characteristics of the Field and the Domain at the time they are alive and painting. Sawyer has devoted considerable attention to the work and lives of jazz musicians, arguing that the most successful ones develop a deep and intimate knowledge of the Domain and its relationship with the Field. Those musicians develop and carry an internal mental model of the Field and the Domain (Csikszentmihalyi and Sawyer 1995; reprinted in Csikszentmihalyi, 2014b).

Other Systems and Systems-like Approaches in the Study of Creativity

Additional systems approaches to studying creativity at varying levels of analysis have evolved since the mid-1980s. Many do not explicitly use the term "systems." They range from those that acknowledge the influence of proximal and distal environments upon creativity to those that, like the Systems Model, suggest that environment is an equal co-creator in the manifestation of creativity. For a general sense of these approaches and how they have evolved, following is a rough chronology. Most of the 10 approaches listed here have dedicated articles within the *Encyclopedia* and/or are discussed in other articles.

1. Gruber's Evolving Systems Approach (ESA) (see summary by [Stahl and Brower, 2011](#)) is a theory and method for studying creative individuals. While examining purpose, affect, and knowledge within the creative person, the theory and method were constructed to emphasize the ongoing environmental influence upon the creator.
2. Amabile's Componential Model of Creativity is an influential systems model that identifies the circumstances conducive to creativity as those at the intersection of Domain Skills, Intrinsic Motivation, and Creative Thinking and Working Skills.
3. Gardner's Symbol System Approach (SSA) proposes four levels of analysis—Biological, Psychological, Epistemological (The Domain), and Sociological (The Field)—in the development of extraordinary cognitive achievements.
4. Sternberg and Lubart's Investment Model of Creativity argues that creative persons need to pursue a new idea early in the idea's life cycle, sell the novel idea to the Field, and then back away, allowing others to sustain the idea. Central to this concept of buying low and selling high is the influence of environmental context.
5. Feldman identifies seven dimensions of creative development, most of which have a strong sociocultural influence, that permit individuals to develop extraordinary creativity in particular domains.
6. John-Steiner influenced by Vygotsky's theory on the central importance of interpersonal experiences in learning and cognitive development has developed a body of work supporting the crucial role of collaboration in the development of creative products.
7. Simonton's Evolutionary Model argues that individuals, through a variety of influences, including the zeitgeist or current social environment, generate a vast number of ideas and combinations of ideas.
8. Puccio and Cabra's Creative Change Model illustrates how person(s), process, environment, and product influence one another, leading to creative change within organizations.
9. Hennessey's Classroom Systems Model situates the skills and knowledge necessary for an individual's creativity within the "Little c" (classroom or workplace) culture and positions that within the "Big C" (geographical area, ethnic group, or nation) culture in order to illustrate the continuous influence of multiple levels of culture upon creativity.
10. Glăveanu, in what could prove to be groundbreaking systems model, has proposed a cultural framework of creativity that views creativity as a sociocultural-psychological process. Recasting culture more broadly than in the tightly defined definition central to the Systems Model, he argues that because creativity is both individual and sociocultural, both levels of analysis explain how creative persons engage in cultural participation. Glăveanu uses craft-making to illustrate that a strict view of domains excludes amateur craftspersons who are also engaging in cultural participation. This conception of systems holds promise as a possible resolution to the thesis–antithesis divide between the Individualist (small c) and the Socioculturalist (Big C) paradigms.

Newer Systems Approaches to Studying Creativity

Chaos Theory and Complexity Theory

Nonlinear dynamical systems theory (chaos theory) and complexity theory are two dominant derivatives of the older systems thinking of the 20th century. Both have been widely applied as theoretical frameworks in multiple disciplines, particularly in organizational science, innovation studies, engineering, computer science, and the social sciences. A few examples of how both have been applied in creativity research are provided.

Chaos theory, which is evolving rapidly from the field of mathematics, is a way to understand the flexibility, order, disorder, adaptability, complexity, and self-organization of systems. The dynamic component refers to the fact that these systems are temporally unstable; they change over time. The nonlinearity component, rather than referring to the traditional relationship between an independent and a dependent variable, signifies the randomness of the internal components of the system. It is a tenet of chaos theory that an underlying order or pattern can, with sufficient exploration and testing, be identified under the apparent disorder of the system.

Complexity theory is not one theory, but a mathematically based science of exploratory research into self-organizing, emergent behavior within complex systems ([Poutanen, 2013](#)). It explores how order emerges from the interaction within a system and reflects a hope for eventually identifying transdisciplinary principles of emergence.

Following many years of research into optimal experience (flow), Csikszentmihalyi proposed that the order underlying all complex systems can be represented by the complementary processes of differentiation and integration, a mechanism that accounts for the development of all living systems "from the simplest amoeba to the most sophisticated human creature" ([Csikszentmihalyi, 1996](#), p. 362). All complex systems seek differentiation (movement toward uniqueness and change by taking on new parts and functions) and concurrently seek integration (working to maintain continuity and stability). Csikszentmihalyi argues that complexity underlies all systems including, but certainly not limited to, schools, organizations, neighborhoods, families, cities, cultures, and individuals. Some entities are more highly optimized due to higher levels of, and a better balance between, differentiation and integration.

Following Csikszentmihalyi's earlier work applying methodologies to explain complexity within schools and families, [Gute et al. \(2008\)](#) applied the framework to study creativity. The project explored complexity, as measured by the four combinations of high and low levels of differentiation and integration, in the early family lives of nine eminently creative persons: Wayne Booth, John Hope Franklin, Oscar Peterson, Ellen Lanyon, Nina Holton, Hazel Henderson, Freeman Dyson, Robertson Davies, and an anonymous psychologist. All were among the 91 participants of the Creativity in Later Life Study ([Csikszentmihalyi, 1996](#)). Consistent

with chaos theory's supposition that an order underlies the apparent disorder of all living systems, participants' coded recollections identified significant evidence of the interplay between integration and differentiation, which served as a catalyst for the optimal experience (flow) common to exemplars who have made meaningful changes to domains.

The self as a complex system is developing as an important level of analysis for complexity theory. Csikszentmihalyi and Rathunde (1998) enumerated the theoretical underpinnings of psychological complexity and reported their findings on the ontogenesis of psychological complexity among highly creative exemplars, arguing that creative contributors to the culture, in part through ongoing interactions with their respective fields and domains, build a set of cognitive, social, emotional, and behavioral capabilities representing opposites. Their claim holds that it is the ongoing processes of differentiation and integration that allow them to build a constellation of opposite traits (i.e., their psychological complexity). The theory holds that highly creative individuals seek differentiation by exercising their agency, divergent thinking, playfulness, extroversion, energy, and iconoclasm. The theory holds that highly creative individuals seek differentiation by exercising traits such as agency, divergent thinking, playfulness, extroversion, energy, and iconoclasm. At the same time, creative persons seek integration by exercising opposite traits such as communion, convergent thinking, discipline, introversion, quietude, and tradition.

Gute et al. (2016), in an investigation to further explore the mechanism—identified by Bunge (2004) as critical for an effective systems approach—by which eminent achievers build their repertoire of cognitive, social, and emotional opposites, undertook a thorough analysis of evidence of both extraversion and introversion within the experience of jazz pianist and composer Oscar Peterson (interview transcript from the Creativity in Later Life Study, Csikszentmihalyi, 1996). They found significant evidence that Peterson intentionally and consistently developed his introversion (i.e., building his integration) as a counterbalance to his naturally strong extraversion. The result was that, over time, Peterson experienced emergence a new ambidexterity that served him in his efforts to influence the field and contribute to meaningful domain changes as both a composer and performer. The identification of this mechanism, which McAdams (2005) has separately identified as making characteristic adaptations, brings us closer to accounting for the process of emergence in highly creative persons.

Poutanen (2013) provides an important caveat for applying complexity theory within the social sciences, where complexity concepts are still largely metaphorical. The fundamentals of complexity science are in mathematics. While we are a long way from employing the mathematics of complexity to measure the quality of emergence within the person or a sociocultural system, advances in computational creativity may yield the development of algorithms that can expand complexity theory and explain creativity beyond metaphor and theory.

Conclusion

Systems approaches to creativity have been increasing in number and growing in influence for roughly the second-half of creativity's life as a research arena. There might now be reason to believe that the fracture between those studying creativity on the sociocultural level and those investigating it on the individual level can begin to heal. Approaches such as Glăveanu's sociocultural-psychological model can certainly help point the way. Moreover, chaos theory and complexity theory, while still young approaches, offer new tools for exploring and measuring the dynamics within systems at all levels of analysis. Bunge characterized how newer systems approaches can move us in the right direction (2003): "Individualism sees the trees but misses the forest, whereas holism sees the forest but overlooks the trees" (p. 75). He goes on to say that only newer systems approaches, such as, but not limited to, chaos theory and complexity theory, will allow us to see "the trees (and their components) and the forest (and its larger environment)" (p. 75) in their full complexity.

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Tactics and Strategies[☆]

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Glossary

Accommodation One kind of tactic, used when the individual him- or herself changes. New information might be obtained, expanding the individual's knowledge base, or the creator's perspective on the problem or topic might change.

Assimilation A second kind of tactic, used when the individual changes the problem or representation of the problem.

Metacognition Thinking about thinking; the recognition that individuals can control their own thinking.

Overjustification Occurs when the person changes his or her opinion such that some activity that was initially intrinsically motivated becomes extrinsically controlled.

Procedural knowledge 'Know-how,' information about how to get something done. It is distinct from declarative, conceptual, and factual information. Tactics are the actions prescribed by procedural knowledge.

Social loafing One explanation for the superiority of working alone over brainstorming. It occurs when people assume that someone else in the group will complete the task at hand.

Introduction

There are a number of things that can be done if a person wishes to increase the creativity of his or her own thinking and behavior. Tactics are particularly useful in this regard. They may be defined as consciously-used methods for increasing originality and ideation. Tactics also require an interest in being creative. They are intentional, and the individual will not expend the effort unless he or she is interested in being creative. They do require a certain level of maturity. That is because metacognitive; they require the recognition that we can control our own thinking, and this is not apparent until early in adolescence. They are also metacognitive in the sense that they are not dependent on basic (effortless) cognitive processes. This provides some optimism; it means that everyone, at all levels of ability, can probably enhance his or her creativity if the right tactics are identified and intentionally employed.

Procedural *knowledge* is necessary for tactical behavior. Procedural knowledge is 'know-how.' It is information about *how* to get something done. It is distinct from declarative, conceptual, and factual information. It might be most accurate to say that tactics are the actions prescribed by procedural knowledge. The tie to knowledge does raise the possibility that intelligence is involved. After all, intelligence is related to how well individuals learn and remember information. Still, the tie to intentions and the interest in being creative, which means original rather than conventional, suggests some separation of tactics from general intelligence. In sum, tactics are *relatively* distinct from traditional intelligence and general ability. Certainly creative thinking depends on both declarative and procedural knowledge, not one or the other.

Along the same lines tactics do not work in isolation. Attitudes are, for example, related to tactics. One relevant attitude concerns the belief that one is capable of creative thinking. The individual must also be interested in creative ideas; he or she must be willing to take

[☆]*Change History:* July 2017: M.A. Runco updated the text in this article. August 2019: His affiliation changed. Updates include clarification of how tactics are metacognitive and how tactics may be classified and used.

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risks and try something new. A creative attitude will insure that the individual approaches problems and tasks, if not life itself, assuming that it is possible and valuable to be creative. That individual is likely to learn and employ tactics for creative thinking. This is especially important because tactics can be learned, and attitudes are easy to change. Unlike personality traits, which represent stable tendencies, attitudes are relatively malleable. These ideas about the possibility of changing attitudes (e.g., so the value of creative ideas is foremost in one's thinking) and learning tactics have clear implications for efforts to enhance creativity.

Classifying Tactics

Tactics for creativity and originality have been classified in several different ways. These classification schemes are reviewed here. It is helpful to know which tactics are related to, and perhaps complement, other tactics.

One useful distinction between the different kinds of tactics was presented by Sidney Parnes. He referred to *let-it-happen* tactics and *make-it-happen* tactics. Incubation is an example of the former. Incubation cannot be forced, but it can be made more likely by taking a break from one's work, and perhaps by taking a walk or finding some optimally distracting activity. As a matter of fact research at Stanford University pointed specifically to taking walks as a means of letting creativity happen. Let-it-happen tactics also include (a) being open to change and serendipity and (b) trusting your intuition and hunches. In these cases, the individual is not directing the process but instead allows it to occur and simply appreciates the results. Individuals may go as far as to put themselves in a position where incubation, serendipity, and the like are highly likely to happen. It may be that all tactics allow information processing that is below the level of consciousness, with at least part of the benefit is beyond control. In a sense let-it-happen tactics may involve letting natural (e.g., intuitive) processing take place.

Make-it-happen tactics are more numerous in the creativity literature. Unlike let-it-happen tactics, make-it-happen tactics are usually more detailed step-by-step procedures. "Be a contrarian: Think of things no one else will," is an example of a make-it-happen tactic. For obvious reasons most of the efforts within schools, organizations, or training programs will involve make-it-happen tactics, simply because they are intentionally and systematically guiding creative thinking. The best of the programs probably also inform participants about let-it-happen tactics, and there are ways to demonstrate the benefits, even in a semi-controlled setting, such as a classroom.

A second way to distinguish among tactics involves stages of the creative thinking process. Certain tactics may be used within one particular phase or stage of the creative process. There are different stage models of the process but most follow from the theory presented by Graham Wallas in 1926, with preparation, incubation, illumination, and verification stages. Let-it-happen tactics are well suited to incubation, for example, just as tactics to 'seek out reliable information' and 'change perspectives' are well suited to the preparation stage.

Each of the four stages can be divided into two subcategories. For preparation, illumination, and verification this division reflects a separation between the subjective and the objective, or between the individual and everything else—the problem, the relevant information, the possible or tentative solutions, the setting, and so on. This subdivision follows from cognitive theories which divide information processing into assimilation (whereby information is changed to fit into an individual's existing personal cognitive structures) and accommodation (whereby the personal conceptual structures are changed to take advantage of the new information). (This subdivision for incubation may not reflect subject and object, but incubation is largely personal and subjective.)

Assimilatory strategies are those with which the creator changes the problem or representation of the problem. He or she might *turn the problem on its head*, for example, or *work backward* from the desired objective or solution to the initial state. Working backwards works especially well for scheduling and travel arrangements. Strategies using accommodation are those with which the creator him- or herself changes. New information might be obtained, for example, expanding the individual's knowledge base, or the creator's perspective on the problem or topic might change by investigating different points of view.

Changes of perspective represent what may be the most general kind of tactic. This is because such changes underlie a variety of more specific tactics. Turning a problem on its head, taking time away from the problem, traveling, *seeking out criticism* or input, and many other tactics rely on some sort of change in perspective.

Problem finding is a kind of preparation and can be easily related to both identifying and defining problems such that creative solutions are more likely. Many problem finding tactics involve information or other resources; just above I alluded to a 'seek out reliable information' tactic, which is a good example. 'Question assumptions' is another example of a tactic that applies well to problem finding. Like "change your perspective," questioning assumptions is a broadly-applicable tactic for creativity.

The tactic 'question assumptions' can also be worded 'do not make assumptions.' This rewording is only noteworthy because it highlights the last distinction that can be used to classify tactics. On the one hand there are tactics that suggest learning new behaviors. 'Seek out challenges' is an example of this kind of tactic. 'Do not make assumptions,' on the other hand, is an example of what can be called an *avoidance tactic*. This kind of tactic suggests what should be avoided, like assumptions, routines, and conformity.

James Adams' excellent volume, *Conceptual Blockbusting*, reviews many different kinds of avoidance tactics. What he suggests we avoid are conceptual blocks, which he then divides as follows:

- Perceptual blocks occur when we define a problem too closely or too generally, or we ignore important information or a useful perspective. We need to avoid preconceptions and stereotypes.
- Cultural blocks occur when we fail to utilize fantasy, play, daydreaming, and humor because, in our culture, they are not associated with serious work. Taboos can create blocks.
- Environmental blocks occur when we are distracted by our immediate environment, including people with whom we live or work.

- Emotional blocks occur when we are afraid of taking risks or are not comfortable tolerating the ambiguity that may be necessary while we incubate or think further about a problem. We may also be uncomfortable postponing a decision or solution or with challenges.
- Intellectual and expressive blocks occur when we are inflexible or do not consider alternative media for representing a problem. We might also fail to obtain the most useful information. We might find a solution but fail to record it.

Each of these ideas can be translated into a recommendation. The last idea, for example, concerning the recording of our ideas, implies that we keep a pencil and paper next to the bed, in case we wake up with a good idea. We might take a small piece of paper and short pencil when we jog, and a small digital recorder when we drive. Many people have noticed that ideas are fleeting and thus there is a benefit to always being ready to record them.

David N. Perkins and Robert J. Weber described the role of tactics in their work on invention. They listed ‘search strategies,’ which are used to seek out information and options. They identified the following:

- Sheer chance.
- Cultivating chance (searcher deliberately exposes self to wide semi-random input).
- Systematized chance (survey of a number of possibilities within a defined set).
- Fair bet (prototypes a possibility with expectations that it will work with modifications).
- Good bet (prototypes from principle and experience).
- Safe bet (derives by formal methods something that almost certainly will work) (1992: 321–322).

Weber individually described the invention and refinement of inventions such as the Swiss army knife and the chair. He listed the following tactics:

- Finding ideas in nature.
- Assemble (the parts or components) for complexity.
- Fine tune what you have.
- Repeat or duplicate a feature.
- Add a feature.
- Delete a feature.
- Rearrange features.
- Join independent inventions.
- Transform and change the scale.

Although Weber’s work was focused on invention, several of these strategies apply to all kinds of creative work. In fact, several parallel tactics are elsewhere recommended specifically for creative activities. *Finding ideas in nature*, for example, has been regularly suggested in the creativity literature. It is similar to other tactics as well, including ‘borrow and adapt’ ideas from others (appropriation), and even ‘find an analogy.’

The use of analogies may be particularly powerful: Eli Whitney developed the cotton gin after seeing a cat trying to catch a chicken through a fence; Samuel Morse apparently put stations in the telegraph after thinking about stagecoaches changing their horses periodically; Pasteur used an analogy of grape and human skin; the benzene ring may have been suggested by a dream of a snake biting its own tail; George Bissel used an analogy of a brine pump being used as an oil pump; James Watt was inspired to design the steam engine after observing a tea kettle; and Sir Marc Brunel borrowed from a worm for his work on underwater tunnels. Velcro and hundreds of other creative insights have resulted from the creative person finding apt analogies.

Many famous insights have resulted from a more direct borrowing strategy. Freud borrowed heavily from neurology and the medical model when describing the psyche; Piaget borrowed from biology in his theory of cognitive development; Darwin drew from geology in his theory of evolution. Musicians often borrow from various styles, the result being an original integration. Elvis Presley, for instance, apparently borrowed from gospel and country music. The Beatles brought an orchestra to rock ‘n’ roll. Apparently some of the best appropriations are from very different domains or styles.

Interpersonal Tactics

As was implied by the discussion above about procedures that can be used by parents, teachers, and supervisors, tactics can be interpersonal. Parents and teachers in particular should encourage children and students, but should be careful to avoid overjustification. This occurs when a person changes his or her opinion such that some activity that was initially intrinsically motivating becomes extrinsically controlled. Incentives and rewards are common extrinsic controls, and when individuals see them, they often assume that they are the reason for their actions—even if those same actions were intrinsically motivated moments earlier. This is especially disconcerting because intrinsic motivation is so often related to creative thinking.

Parents and teachers should shape confidence and ego strength as well. This is particularly important because original ideas are often unconventional, and children become quite sensitive to peer pressure in preadolescence. During that period they may shy away from their own original insights. If they have ego strength, they may maintain their originality and avoid common slumps that occur during this period.

Another interpersonal tactic is part of brainstorming programs. Participants in brainstorming groups are asked to generate as many ideas as possible and to postpone criticism. The participants are required to be careful of what they say to one another in an effort to maximize ideational output and minimize evaluation and inhibition. The tactic here is best summarized as 'postpone evaluation.' It is a postponement, not an elimination, because usually some evaluation or verification is needed, at least late in the creative process.

Admittedly, the empirical evidence suggests that brainstorming may not be the most effective use of time. Working alone may be better. When people are in groups there is a tendency toward social loafing, and people may assume that someone else in the group will complete the task at hand and thus not really invest much time or effort. Creative insights are unlikely when there is little investment of time and effort. But here again, it may be best to think of postponing rather than eliminating team work. Teams do provide diverse perspectives and resources that a person working alone may lack. Creative ideation is the most likely when an individual works alone, since there are no pressures on conventional thinking nor costs for thinking in an unusual way, but at some point teams may contribute to the refinement or implementation of the idea.

It may be very difficult to postpone criticism, as required for brainstorming. Humans are highly social animals and even if someone does not articulate a concern, usually people can read the signs and infer that their own thinking is being questioned by observers. But as noted above, it may be a good idea to postpone but not eliminate evaluation.

Most likely a balance of divergent thinking and convergent thinking will benefit the process as well. James March recommended something like this when he described a balance of play and reason. He suggested several tactics for finding a balance, including treating (a) goals as hypotheses, (b) intuition as real, (c) hypocrite as a transition, (d) memory as an enemy, and (e) experience as a theory. The last of these—experience as a theory—is another way of suggesting that we question assumptions.

March suggested that the five tactics be used alternatively, with a temporary suspension of 'reasoned intelligence.' In his words, "play and reason are functional complements. ... They are alternative styles and alternative orientations to the same situation. ... Our design problem is either to specify the best mix of styles or, failing that, to assure that most people and most organizations most of the time use an alternation of strategies rather than persevere in either one" (1987, p. 77).

The Wright brothers, Orville and Wilbur, used an interesting interpersonal tactic when they worked on the first flier: they argued. Wilbur and Orville would take opposite sides of some technical problem, debate the issue, then switch sides and debate some more. It was, then, an intentional, tactical technique that the brothers used to help solve the problems of flight. Very likely the argument tactic led to a questioning of assumptions and a consideration of alternative perspectives. Biographies of the Wrights describe how vehemently the brothers argued, but it must have been in the service of creative thinking because at some point they would switch sides and each argue the opposite view.

One kind of tactic is interpersonal but focused on avoiding rather than collaborating with others. I am referring to the contrarian strategy. Here the creator does what others are not. This works some of the time because creativity requires originality, and a contrarian will be original because he or she is doing what others are not. Examples include Jean Piaget, Sigmund Freud, Duke Ellington, and Pablo Picasso. This is, however, a difficult tactic because it requires discretion and careful moderation. If someone relies on contrarian tactics they could reinvent the wheel, even though if they asked, they would be told that the wheel already exists. If it already exists most people will not reinvent something—but a contrarian could go too far and do just that. Also, sometimes there is a good reason others are not doing something. It may be stupid, so people are not doing it. Originality is not sufficient for creativity, so contrarianism is not in and of itself adequate. It can be taken too far.

Conclusions

Tactics can be defined by (a) distinguishing them from strategies, which are general plans rather than specific in-process techniques; (b) distinguishing procedural information from conceptual and factual information; and (c) distinguishing cognition from meta-cognition. Tactics take various forms and can be of the let-it-happen variety or the more structured and effortful make-it-happen variety, although here there is some blur and the distinction is imperfect. Make-it-happen strategies may involve some relaxation and preconscious processing, in which case there is a let-it-happen component to them. Tactics can be personal or interpersonal; they can focus on the problem, as a kind of assimilation (e.g., 'turn it on its head'), or on the person who is dealing with the problem, as a kind of accommodation (e.g., 'change your perspective').

Tactics involving shifting one's perspective seem to be the most general. Some perceptual shift underlies many other tactics. The contrarian tactic, on the other hand, may require the most tact and discretion. This tactic did not always work effectively and might be best when used in moderation. Otherwise the result might be extreme but inappropriate originality, which is not synonymous with creativity. Very likely all tactics are best used with moderation and discretion.

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Talent

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'Talent' and 'creativity' are among the most influential watchwords of our time. When searched, they return billions and hundreds of millions of Google hits respectively. Many contemporary discussions center on how to define talent and creativity, and where to place them, in the modern marketplace of ideas. Both terms can indeed be traced far back into history, where conceptions have long been tied to the good, to the new and to prosperity. Ideals around talent in particular have shaped the ways disciplines are pursued and the ways social structures are organized.

This entry will explore modern interpretations of the terms 'talent' and 'creativity' in the context of their historical origins, showing how emphases across different periods have moved from virtue, to religious obligation, to culture (as a means to self-improvement), to genius, to more massified conceptions of everyday ability and creative expression. A brief survey of influential research will set up a discussion of some of the current issues surrounding talent and creativity. These include: the paradigmatic rejection of traditional talent evident in popular culture, the corporate global *war for talent* and creative people under neoliberal capitalism, the loss and acquisition of talent in an age of rapid technological advancement and social change, and new stratifications of skill and creativity in fields such as digital technology, biotechnology and data. The values currently attributed to talent and creativity in an increasingly globalized, digitalized and individualized world will be contrasted with older conceptions which more closely associated high levels of ability with fictional imagination, ethical action and virtue.

Historical Conceptions of Talent and Creativity

When Plato discussed the roles that natural human abilities play in society, he noted that the ideal polis was characterized by individual citizens pursuing worthwhile goals and skills which did not limit human flourishing (Irwin, 1995, p. 223). In his view there was a natural spread of gifts amongst citizens, equally distributed (in most fields) between men and women. While logically people were at different stages of development, under favorable circumstances progress from evil to good and from ignorance to knowledge could be made (*Phaedo*, 57a-118a). Plato noted that the proper cultivation of legitimate 'arts', such as medicine, carpentry, gymnastics and the military, was to be distinguished from a mere love of money. Aristotle's *technê*, in a similar fashion to Plato, associated the pursuit of talent with the ability to conceptualize proper ethical action. The ends of all activity, in Aristotle's view, aim at some good; but the question is how that good affects the individual and the society (*Nic. Ethics*, 1094a1-2). In Western culture, talent and the ability to create *new action* were from this early point set in the context of virtue.

Plato discussed creativity (not in precise terms, but its essence) with respect to the talents of the epic and lyric poets and the performances of dancers and rhapsodies. While he was highly skeptical of the contribution and value of artists, the imaginative capacities of poets he explained as deriving from a spiritual state of being inspired and possessed by divine forces.

And as the Corybantic revellers when they dance are not in their right mind, so the lyric poets are not in their right mind when they are composing their beautiful strains ... For the poet is a light and winged and holy thing, and there is no invention in him until he has been inspired and is out of his senses (*Ion* 534a).

This is relevant to modern thinking in that Plato might have agreed that talent is to be found across nations, races and genders (*The Republic*, IV 332e), but creativity—rather than being abundant in all people or fields—was other-worldly. Put another way, while citizens in the polis were encouraged to better themselves and pursue their talents, the creative powers that brought about imaginary worlds or transformative ideas were not necessarily found in everyday practice and engagement. Notably, the Romans did expand the concept of creativity to other artists such as painters and had a specific word for the human creator: *creatio* (Tatar-kiewicz, 1980, p. 246). The Latin origin of the word *genius* characterized innate ability or inclination as an "attendant spirit present from one's birth" (Colman, 2015, p.312).

Talent was also discussed in ancient Chinese philosophy, which emphasized directing effort towards one's passions. Confucius claimed that "talent is hard to find" (*The Analects of Confucius*, VIII) and like Plato and Aristotle, related talent to virtue: "The junzi (gentleman) does not accept being known for petty talents but accepts receiving great burdens. The small man (villain) does not accept receiving great burdens but accepts being known for petty talents" (Book 15). Creativity, in Chinese philosophy, was an ideal linked to exemplary intention and good character, which positively impacted the environment (Niu, 2012). Showing how these concepts have sparked renewed interest in recent years, Christine Gross-Loh noted that hundreds of Harvard students were being drawn to Chinese teachings which painted "heart" and "mind" in a synonymous context, which in turn allowed them to think differently about how they pursued their own talents (2013).

In the Christian period, as historian Wladyslaw Tatarkiewicz explained, creation from nothing (*creatio ex nihilo*) was understood as only the domain of god. Men made art but were not capable of *creating* (1980, p. 247). Before the 14th century, talent was referred to denotatively as a noun, a unit of weight and then of currency i.e. 'a talent of silver' (Adamsen, 2016, p. 77–78). In the Parable of Talents (Matthew 25: 14–30) talent referred to both a unit of currency, and the skill (also natural ability, endowment and responsibility) of making profit in the marketplace. As Justin Ukpong argued, the parable can be read in both theological and social-historical contexts, either as a confirmation of the two servants who trade and thus serve god's kingdom; or of the punished and rejected third servant who buries his one unit of talent (metaphysically suppressing his abilities). The parable also embodies the Christian ideal of the meek, "prophetic voice" who shows subservience to god (Ukpong, 2012, pp. 191–192). Holden and Tansley note that from the Middle Ages, definitions of talent morphed from associations with units of weight and currency into increasingly metaphysical realms, designating innate capacities and outstanding accomplishments in mental and physical realms (2008).

Towards the end of the Enlightenment Jean-Jacques Rousseau lamented what he saw as the separation of talent from virtue, and of skill from morality: "we no longer ask if a man has integrity, but if he has talent, nor whether a book is useful but if it is well written ... There are a thousand prizes for fine discourses, none for fine actions" (2012, p. 31). By contrast, the 19th century German concept *Bildung* emphasized culture as the path to self-improvement. Culture, especially as denoting engagement with the world, learning, experiencing and forming skills such as language and custom designated "the properly human way of developing one's talents and capacities", or what is "given" (Gadamer, 2004, p. 9). Immanuel Kant, as Hans-Georg Gadamer noted, spoke of the duty one has to oneself to cultivate a natural talent, but *Bildung*, he argued, is more than a means to an end; it is an inward, almost spiritual process of development. One requires *Bildung* to form the ideal image of a human; a character with cultivated gifts as an acting being (Gadamer, 1975, pp. 9–13).

In each of these philosophical contexts, the learning of craft, formation of skill and acquisition of knowledge—in other words, the cultivation of talent—had some relationship to ethical action. By the 18th and 19th centuries however, more individualized interpretations of talent and creativity had emerged. William Deresiewicz has written of the trajectory of artists from artisans to geniuses; that the solitary virtuosos of the Romantic era offered "higher truths" to the elite class in a more secularized, post-revolution world. Creative and supremely talented idols such as Blake, Goethe and Beethoven represented a new creed of artists as the sole creators of originality, which led to the recognition of later figures such as Picasso and Wagner as cultural aristocrats. Linguistically it is important to note that only from the 19th century was the term 'creativity' commonly used to describe the practice of artists: "not only was it (art) regarded as creativity, but it alone was so regarded. 'Creator' became a synonym for artist and for poet" (Tatarkiewicz, 1980, p. 249).

In the 20th century however, art to a large extent became institutionalized. Museums, galleries and universities transformed the artist into a middle-class professional and, with the help of other cultural forces, artists' spiritual aristocracy was demystified (Deresiewicz, 2015). From the beginning of the 20th century the sciences and nature also came to be recognized as creative, which for some was seen as a transference of "concepts proper to art" (Tatarkiewicz, 1980, p. 249). These shifts were an important precursor to later twentieth-century conceptions of talent and creativity which saw much broader dissemination of the terms, and indeed, in some popular culture domains, the rejection of traditional ideals of excellence for more personality-oriented, mediated presentations of selfhood.

Contemporary Research on Talent

Research on talent and creativity in the second half of the 20th century and early twenty-first century not only broadened conceptions from the lone intellectual or artistic genius but helped challenge models for identifying talent and creativity. Many varied categories of giftedness have now been established, some of which assert that academic ability—especially as judged by schooling systems of grades and tests—is not synonymous with creativity, or potential for high-level performance. Margaret Heffernan cited the important examples of Richard Branson, Whoopie Goldberg and Jamie Oliver who were not recognized as having 'conforming' creative potential in their youths (BBC Radio 4, 2017). Their experiences illustrate how notions of talent were liberated from more rigid, aristocratic and singularly artistic definitions.

Research on talented individuals has also paid close attention to how different environments affect the identification and nurturing of natural ability and thus promote or limit creative potential. Jane Piirto's framework examined genetic, emotional and cognitive aspects, as well as the social conditions and support environments for talent which she calls "the suns" (2000). The three major suns, or spheres of influence on talent are: home, community and culture, and educational institutions. James Flynn, famous for the Flynn Effect study which found that intelligence increased over the course of the 20th century, also stressed

that external non-cognitive factors could cripple talented or intelligent people. Flynn furthermore noted that educational institutions were potentially less productive for talent development than the cognitively demanding modern world of work (as noted in his study of Dutch adults, adolescents and children, BBC Radio 4).

A key characteristic of successfully nurturing innate ability is the concept of “flow” coined by Mihaly Csikszentmihalyi (1990). Flow refers to a deep state of engagement, concentration, tenacity, sense of enjoyment, of control and of being rewarded by an activity. MacDonald, Byrne and Carlton’s empirical study applied the conditions necessary for flow to musical composition. These conditions included: clear establishment of goals, immediate feedback, a balance between challenge and skill and reduced fear of failure (2006, p. 296). They confirmed that high levels of flow correlated with high levels of creativity (p. 300). In another study on team flow in business settings, van den Hout, Davis and Weggeman compared the code words, actions and phrases used by teams in sports settings to business. Considering how this communication allows teams on a field to function as a blended, cooperative whole (2018, p. 391), he noted that “For managers, the key is to know how to build a team of people with a mission and complementary skills, and then empower them to develop the prerequisites of team flow” (p. 413). In such settings the combination of individual talent and a group dynamic with flow characteristics can lead to even higher levels of creative output.

Abraham Tannenbaum (1983) focused on the field of gifted education and the character of creatively talented individuals. Observing that there are socially disapproved types of talent such as Machiavellianism and demagoguery, he broadened definitions of giftedness beyond intellectual ability to include skill that “enhances the moral, physical, emotional, social, intellectual or aesthetic life of humanity” (p. 86). Like Piirto, who defines talent in terms of domain-based skill (the rules for which are determined by established experts) and as that which reflects an inborn propensity to perform or demonstrate predictive behaviors in a certain domain (2010), Tannenbaum also referred to the complex external and environmental forces influencing talent. He stressed however that *developed* talent is displayed only in adults. Gifted children show the potential for becoming recognized in various domains when they exhibit traits such as superior general intelligence or special aptitudes in other areas. Tannenbaum’s developed capacities were further divided into categories ranging from “scarcity talents” which produce major breakthroughs transforming fields such as science and medicine to “anomalous talents”, which pertain to small-scale skills such as cooking and gardening (1983, p. 59-60). Such variation in the possibilities of identifying talent corresponds to discussions of big C and “little-c” or “mini-c” creativity (Beghetto and Kaufman, 2007), where scaled categories reflect different degrees of significance.

Francoys Gagné’s 1993 survey of 20th century definitions of talent showed how researchers such as Guilford, Gardner and Taylor (among many others) helped to extend thinking about established, specific domains of talent. Like Tannenbaum, Guilford and Taylor also emphasized that recognition of creativity need not necessarily be limited by scholastic intelligence scores (see Gagné, 1993, p. 69). Guilford’s Structure of Intellect Model distinguished various types of operations (such as memory retention and evaluation), products (such as systems and implications), and contents (visual, auditory, symbolic, semantic, behavioral) to create a psychometric testing model measuring 180 intellectual abilities or factors (1956). Gardner’s seven types of intelligence included the linguistic, the musical, the logical-mathematical, the spatial, the bodily-kinesthetic, as well as two personal intelligences, the intra-personal and the interpersonal (1993). Taylor’s 1967 Multiple Talent Approach, largely devoted to possibilities for teaching in the classroom with a focus on workforce skills, categorized talent into the following fields: academic, productive thinking, communicating, forecasting, decision-making and planning. Gagné’s own work proposes that human abilities can be grouped according to: behavioral domains (e.g. perception, social and affective behaviors); occupational fields (e.g. arts and sports); and degrees of development—from natural aptitude to systematically developed abilities (1999). Gardner and Taylor’s models are still commonly referred to in contemporary discourse around critical thinking and creativity.

Current experts in the field such as Heffernan (BBC Radio 4, 2017) and Carol Dweck (2016) have more recently suggested that the notion of fixed talent itself is unhelpful. This is because traditional systems of identifying potential in schools, universities and professional interviews have proven to be poor indicators of performance. “Believing that talent is precious and rare is wasteful because it writes off most people” said Heffernan (BBC Radio 4, 2017). Rather, as revealed in Heffernan’s interviews with experts such as Laszlo Block (former head of Google’s ‘People Operations’) factors that lead to exceptional creativity, high job performance and longevity tend to be: tenacity, grit, resilience, comfort with ambiguity, a growth mindset and courage to challenge ideas and authority (BBC Radio 4, 2017).

The Paradigmatic Rejection of Traditional Talent and Expertise from the Late 20th Century

While academic studies in recent decades have remained committed to nuancing understandings of giftedness, conceptions of the value of creative skill and talent in certain domains of popular culture have shifted dramatically. In the late twentieth-century the vast democratization of entertainment and proliferation of video technology brought with it the celebrification of everyday, ordinary citizens across a range of mediums. In the US especially, fame spread to criminals, doctors, lawyers, body builders, radio jockeys, religious figures, politicians, actors in television commercials, a wide variety of musicians and many other individuals who were able to attract and sustain media attention. These figures differed markedly from their famous predecessors in highly theoretical, rigorous fields of art, science and politics (such as Mozart, Marie Curie and Abraham Lincoln - known for contributions of history-defining oeuvres and masterpieces) in that they were *famous for being famous*, to invoke Daniel Boorstin’s well-worn cliché (1971).

Media flashpoints, especially in the 1990s, such as a kidnapped child, a corporate lawsuit, a celebrity divorce or murder (the case of O.J. Simpson is an often-cited example) or the death of a musician captured public fascination and created cultural obsession around mediatized reality and identities (Turner et al., 2000, p. 2). Importantly, the focus was usually not on individuals' natural gifts, displays of excellence in a specific field or creative influence. Idolatry had morphed into consumption-oriented engagement driven by emotional narratives and the commodification of self-hood—as later figures such as Kim Kardashian would come to exemplify. When asked in a *60 Minutes* interview what her talent was, Kardashian replied: “it is a talent to have a brand that’s really successful, off of getting people to like you for you” (Kim Kardashian facing backlash after 60 Minutes interview, 2016). Under definitions of entrepreneurial creativity (see Della Corte and Del Gaudio, 2017) Kardashian innovatively generated new products, services and organisations through technological forms of creativity (reality television and social media), capitalizing on and revolutionizing modes of consumption under free market capitalism.

With the proliferation of content required to fill the 24-h news cycle came the need for an endless supply of television ‘talent’ or participants. The thematic focus on voyeurism in confessional television programs such as *Jerry Springer* (1991–present) and *Ricki Lake* (1993–2004) and early surveillance-based comedies and dramas such as *Candid Camera* (1948–2014) and *COPS* (1989–present, featuring police patrolling for and arresting criminals) relied on idiosyncratic, bizarre, controversial, dangerous and excessively emotional or sensational performances. The paradigmatic shift that occurred, especially with the explosion of reality television hits such as *Survivor* (2000–present) and *Big Brother* (2002–present) and other shows which exhibited the “theatre of neoliberal capitalism” (Couldry, 2008) such as *Dirty Jobs* (2003–12) and *Undercover Boss* (2010–present), was that as viewers co-produced content, they were more often than not cast because of a lack of performing or acting talent. However, while surveillance-competition shows often emphasize hostility, weakness, pettiness and exclusion, a renewed interest in talent (albeit a style of talent which suits a certain kind of mockery entertainment performed by celebrity judges) has been evident in other formats such as *Dancing with the Stars* (2005–present) and the *Got Talent* franchise (2006–present).

The cult status of individuals on newer performance platforms such as YouTube and Instagram highlights the complexities of a new era in the celebration of talent and creativity, as stars masterfully infuse the ability to sell with internet-tailored exhibitions of dynamism and authenticity. While some stars with high internet visibility such as soccer player Cristiano Ronaldo are world-class in long-established domains such as arena sports, for other figures who skillfully inhabit creative technology spaces, such as James Charles and Liza Koshy, talent appraisal centers more explicitly on the performance of personality. Indeed these figures generate value through extending and challenging audiences’ perception around social (and political) topics, in ways that are not necessarily decorrelated from, but are certainly striking, when compared to classical notions of the (divine or artistic) ability to create something transformative or artistically imaginative from nothing. While technology has provided so many people with the means to explore their creative ability and show their talents in popular culture, one consequence is that traditional or historical forms of excellence in fields such as music, art, academia, science and other domains have become less central in modern society due to the volume of competing material. Importantly, online social platforms have also become a key portal through which to criticize and shame individuals, often shifting focus away from skill-based or creative contribution and more toward the vilification or humiliation of individual personalities.

The democratization of talent and proliferation of technological and entrepreneurial creativity has undoubtedly made the terms for appreciating and recognizing talent fairer. But the valuing of so many variations and degrees of skill or craft as *creative* in an unregulated, para-social environment may also risk obstructing socially, ethically and democratically structured standards of talent and creativity. The most poignant cases of this have been seen in the way politicians in the US and the UK for example have popularized socially harmful messages by delivering them entertainingly. Their success in doing this infers talent and creative use of technology, at least in the field of demagoguery, but resulting policies and social changes arguably damage much of the cultural fabric (such as multicultural agendas and recognition of differently abled people) required for nurturing talent and creativity.

The Scarcity of ‘Talent’ in Twenty-First Century Markets

As Brown and Tannock described, “corporate and national policy debates are being framed around the view that intense economic competition has sparked a ‘war for talent’” (2009, p. 377). The war for talent has been characterized as increasingly subject to strategy derived from data, where analysis can help determine which individuals will be successful in the new business structures emerging in high-tech and knowledge-intensive industries. As the world has *gone flat* in terms of the search for talent, traditional geographic, gender and class barriers are disappearing. This has created a different playing field for recruiters, as education standards, training and skill benchmarks transition from nation-based to global paradigms.

Human creativity, according to Kiran Prasad, LinkedIn’s vice president of engineering is increasingly measured by the ability to innovatively dissect, evaluate and present data. Prasad noted that there is an ongoing risk that sought-after skill sets will continue to change rapidly in the future, soon making even presently specialized, in-demand roles such as ‘data scientists’ obsolete (McKinsey and Company, 2015). Yuval Noah Harari noted in 2018 that as machines gradually develop the cognitive skills to compete with humans (surpassing their previous manual competitiveness) artificial intelligence will continue to improve, “and even jobs that demand high intelligence and creativity might gradually disappear” (Harari, 2018).

With forty million workers currently unemployed globally, there is already a “short supply” of people with the required new skills in the rapidly evolving job market, as a recent report by Oxford Economics stated (2012, p. 2). At risk especially are ‘low-skilled’ occupations such as drivers, manufacturing workers and retail cashier positions which are increasingly automated. Analysts

also predict that many white-collar roles in business, legal and medical industries will either disappear to automation or require significant ‘upskilling’. The prospect of large numbers of workers successfully developing such skills in adequate time may prove challenging, as technology advances more rapidly than domains of talent can be established, and as the purpose of so many new jobs is to automate the existing workforce to meet productivity and profit objectives. Harari has questioned how an emerging ‘useless class’ will be able to cope: the ever-changing requisites of talent to perform the remaining roles for humans may be beyond the learning capacities, emotional resilience and stamina levels of many people (2018).

Workers from more diverse corners of the world are however gaining access to the global job market. The ‘brightest’ and the ‘best’ are being hired in the war for talent regardless of nationality, gender, ethnicity or social background, as Brown and Tannock explain (2009, p. 377). While talent is trumping geography (2009, p. 380) and those who possess distinctive skills in the new economy are increasingly mobile, the pitfall is that nationally-focused systems for educating and nurturing talented people will be absorbed into global meritocracy institutions: “for why should a country invest in education if it is easier and cheaper to import already educated workers from abroad?” (Brown and Tannock, 2009, p. 385). What appears to be lacking in the forthcoming meritocracy system is the ability to separate or delineate modern notions of talent and creativity from economic and technological objectives.

Creative Talents Lost and Gained as a Result of Hyper-Technology

Technology is permitting vast numbers of people across the globe to lead more convenient and stimulated lives and to pursue new forms of creativity. Access to information has never been so widespread, infinite or equal and types of talent and creativity are constantly being redefined (see Richard Florida’s highly influential work on the creative class, 2003). The work now performed by machines, from navigation to project management to curating and distributing educational material, leaves ever-increasing free time to focus on honing natural gifts and talents and to apply those skills to creative projects. New jobs in ‘experience design’ and ‘machine learning engineering’ in the technology industries require humans to acquire new talents such as programming scalable computing environments and refining and reading algorithms in their software code (ICD InfoBrief, 2018). In medicine, roles such as ‘reconstructive surgery 3D printing specialists’ and ‘epigenetic counselors’ demand specialized new skills as the processes involved with performing these roles become more complex. Epigeneticists for example possess highly specific talents in charting heritable changes that affect gene activity and expression (Hamilton, 2011).

However, according to UCLA distinguished professor Patricia Greenfield skills such as critical thinking and analysis have declined in the period of hyper-technology, while visual literacy has improved (2009). Basic skills including spelling, numeracy and conversational adeptness are also reported to be in decline (Drago, 2015). Furthermore, creative performance traditions such as those handed down through Australian Aboriginal (Grant, 2014) and African (Awogu-Maduagwu, 2018) dance, singing and storytelling are disappearing as culture, in some respects, becomes more homogenized. As Abbie Smith Rumsey argued, in response to the datafication of artifacts, artworks, literature and other records our first task is “to rescue the past—the full legacy of human knowledge built up over millennia now living in libraries, archives, museums and in people’s homes. Today—and certainly 20 years from now—the first place people look for information, and often the last, is online” (2016). Across the physical spaces Rumsey mentions are also the records of talents; learned, practiced and mastered by generations whose work and hobbies were defined by application to such traditions.

In thinking about the virtue implicit in language around talent and creativity it is important to note that shifting modes of sociality (to digital spaces) and new, highly specialized talent domains pose challenges in terms of social wellbeing. Pew Research interviews for a study titled ‘The future of wellbeing in a tech-saturated world’ with experts such as Rob Reich (Professor of Political Science at Stanford University) suggested that a net harm overall will be felt over the next decade due to loss of privacy and security. Issues include “a degraded public sphere and its new corporate owners that care not much for sustaining democratic governance, the technological displacement of labor due to AI and decreasing dynamism and political autonomy due to additive technologies.” Rich Salz, principal engineer at Akamai Technologies, similarly pointed to “more isolation, less ability to focus, more ability to be deceived by bad actors (fake news) and so on”. Leora Lawton, lecturer in demography and sociology and executive director of the Berkeley Population Center and David Ellis, PhD, course director of the department of communication studies at York University in Toronto echoed these concerns. According to these experts, digital services and devices will keep harming individual welfare and tearing up the social fabric. Welfare concerns specifically include depression, loneliness, video-gaming abuse and even suicidal behavior, especially among teens and young adults (Anderson and Rainie, 2018). These predictions, however, should be considered in the context Euro-centric anxieties about the quality of life as the world becomes more globalized and developing countries advance. They should also be reviewed with regard to previous studies by Piirto, Flynn and others demonstrating how prohibitive external factors affect the nurturing of talent and creativity.

Conclusion

In ancient philosophy, it was acknowledged that people possessed a wide range of skills and talents and that everyone had the potential to improve. From this it should not be construed that ancient societies were fairer or more democratic than those that exist today, but that the intellectuals of the time theorized about the ethical value of talent and creativity. To be creative was to

invoke higher powers of character or divine spirits to bring about that which was imaginative or transformative. While theoretical knowledge (such as mathematics) was technically accessible to everyone to different degrees, knowledge of good action (or virtue/technê) required a different form of talent. Perhaps most pertinent was the notion that the cultivation of abilities should not obstruct the basic needs of human life.

Later periods saw ideals of creativity and talent transferred to aristocratic artists and intellectuals, to professionals and celebrities, and to everyday people. Now there is a new talented elite: the technologically-skilled creative class. Research in recent decades has recognized more specifically defined fields and factors that affect talent creativity, and clearer distinctions have been made between talent and IQ. In popular culture the pursuit of excellence in traditional performing has had to compete with commodified spectacles of personality. Some of the most impacting displays of talent have been designed to exploit voyeurism and incite racially charged populism generating discourse in which virtue is particularly undervalued.

The modern world of work now requires a range of exciting new talents to propel ever-more complex expressions of creativity. A more connected world has the potential to showcase and acknowledge more talent and creativity. But questions remain as to how new talent fields and creative projects will benefit individual societies and the global population, and how, if at all, they will relate to traditional concepts of fictional imagination, ethical action and virtue.

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Teaching Creativity

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Introduction

For most of its history as a topic of interest to psychologists, creativity was thought of as a domain general skill (or set of skills). The cognitive skills underlying creativity were therefore assumed to be largely the same regardless of domain. Creativity testing and creativity training were likewise approached from an assumption that creativity was domain general. That belief about the nature of creativity only began to change toward the end of the 20th century.

In 1998 the *Creativity Research Journal* published the first Point-Counterpoint set of articles in the journal's history. The issue that prompted this debate was whether creativity was domain specific or domain general. But even when making an argument for domain generality twenty years ago, [Plucker \(1998\)](#) acknowledged that "Recent observers of the theoretical ([Csikszentmihalyi, 1988](#)) and empirical ([Gardner, 1993](#); [Runco, 1989](#); [Sternberg and Lubart, 1995](#)) creativity literature could reasonably assume that the debate is settled in favor of content specificity" (p. 179). A few years later, in his 2004 *Annual Review of Psychology* entry on "Creativity," [Runco](#) argued that the concept of domains "must be acknowledged because most of what has been uncovered about creativity is domain specific" and "clarifying these differences is one of the most important impetuses in the literature" (p. 678).

The issue of domain specificity is discussed elsewhere in this encyclopedia (See Domains of Creativity) so this entry will simply assume that creativity is for the most part domain specific without further explanation. That said, most of the work that has been done in creativity training has been done under the assumption of domain generality, and, as will be shown, that work is still important for three reasons:

1. The approaches most commonly used today to teach creativity are still the same ones invented decades ago.
2. Many of those approaches, even though conceived under a domain general framework, can be applied to domain specific creativity training by careful selection of the content of the training exercises used.
3. There has not yet been a great deal of research in the area of domain specific creativity training (Even if such work had been done, of course, it would be beyond the scope of an encyclopedia entry to catalogue for every domain how to teach creativity in that domain. A few examples will therefore have to suffice.)

In their meta-analysis of 70 studies of the effectiveness of creativity training, [Scott et al. \(2004a\)](#) noted two "overarching assumptions [that] shape the content and structure of creativity training" (p. 362):

1. Whether the training is a model-based approach, such as the Osborne-Parnes CPS Model discussed below, or relies on "theory independent techniques, such as brainstorming" (p. 363) to develop divergent thinking skill.
2. Whether training is based on general models "held to enhance creativity across a range of situations that require little modification to account for domain and population differences," or if effort is made to "tailor techniques and models to the unique demands made in a given performance domain" (p. 362). They give one example of this kind of domain specific training, which will also be discussed below.

Overall their meta-analysis found that "more successful programs were likely to focus on development of cognitive skills and the heuristics involved in skill application, using realistic exercises appropriate to the domain at hand" (p. 361).

[Scott et al. \(2004b\)](#), in an analysis of a somewhat larger but less selective sample of training programs, found that divergent thinking (idea production) training was the most commonly used creativity teaching technique, sometimes combined (as in the CPS model) with evaluative thinking practice. Mental imagery training was also common in the studies they reviewed. They found that "some types of training, specifically idea production and cognitive training, proved particularly effective while some commonly applied training strategies, specifically imagery training, proved less effective" (p. 149).

Although these two meta-analyses demonstrated that creativity training can be productive, the assumption of domain generality has hindered the develop of better domain specific methods for nurturing creativity. To understand how much an assumption of

domain generality has handicapped the teaching of creativity, consider this question about the development not of creativity but of more basic skills:

How does one teach a novice a new skill or help someone develop and improve a skill that person already has?

The words “It depends” will almost certainly frame any answer one might give. Teaching a novice a new dance step, teaching a novice how to design a bridge, and teaching a novice how to play a card game would be such different things that it is hard to see how any one answer might apply to all three. Ditto for helping a skillful pool player learn how to line up a bank shot, helping an eager student develop better note-taking skills, and helping a very talented young poet learn a new poetic form. Each will require a different teaching method and (perhaps) a different training regimen.

Is there nothing one can say about all, or at least most, kinds of skill training? How about:

- It is often helpful to break a complex skill down into smaller parts.
- Honing skills usually takes a great deal of practice.
- Distributed practice is generally more effective than massed practice.

Those three things are certainly not true for all kinds of skill development, but they are probably true in teaching many skills — enough so that teacher preparation programs typically share these ideas with prospective teachers. General heuristics such as these hardly constitute a training program, however, because the details of the particular skill will certainly be more important. If one had nothing else to go by, however — if one knew nothing more about how to help a student develop some particular skill — these very general recommendations, while weak, might still be useful heuristics to bear in mind. They might also help guide the development a program aimed at developing a specific kind of skill.

This is the current situation of creativity training in most domains. There are some very abstract heuristics that might be useful in nurturing creativity in many domains but that are primarily of value only when tailored to a specific domain (just as the suggestion that “It is often helpful to break a complex skill down into smaller parts” has training value only if one can tailor it to a specific skill). For this reason, this entry will discuss two of the most widely used and best researched approaches to teaching creativity as a domain general skill and then discuss how these approaches might be adapted to teaching creativity in specific domains.

Divergent Thinking Training

There is an unsurprising similarity to most creativity-training programs. Virtually all include heavy doses of what Guilford labeled “divergent thinking” (1956). Consider the following popular approaches to creativity training:

- CPS (the Osborn-Parnes Model of Creative Problem Solving), where the emphasis is on withholding judgment, going for wild ideas, and following the other dictates of brainstorming;
- Talents Unlimited, where the oft-repeated instructions are to find “many, varied, and unusual” ways to do or think about something;
- Syntectics, where the key idea is simply (but this is never simple) to “make the familiar strange” (Syntectics, 1968).

Divergent thinking involves the production of many ideas in response to an open-ended question or prompt. Knowing what has now become common knowledge — that creativity requires going beyond the known, boundary breaking, risk taking, finding new and unusual ideas — it is not hard to see why Guilford believed divergent thinking was a central part of creativity or why those who wished to assess creative potential have often developed tests of divergent thinking (Runco and Acar, 2012).

The important role divergent thinking plays in creative performance may seem obvious now — it is hard to think about the field of creativity theory and research without referencing this seminal idea — but it was hardly obvious when Guilford proposed it in the 1950s. He identified four parts of divergent thinking:

- fluency (the ability to produce great number of ideas);
- flexibility (the ability to propose a wide variety of ideas);
- originality (the ability to produce unusual and original ideas); and
- elaboration (the ability to develop, expand on, and flesh out an idea).

Divergent thinking is not the alpha and omega of creativity training — when it has been, such programs have sometimes been derided as mere fun and games — and it has not always proven as powerful as its proponents have assumed, but it remains central to most systematic efforts to teach creativity. The most commonly used method to facilitate divergent thinking is brainstorming. Here are the rules:

- *Defer judgment.* The goal is to produce a large quantity of ideas without regard to the quality of ideas (with the assumption that quantity will lead to quality). Deferring judgment means not criticizing ideas (both those of others but perhaps even more importantly one’s own ideas), because criticism leads to more self-censorship and less risk taking. Deferring judgment also means not praising ideas, because once ideas are praised, the element of judgment has been introduced, which will also limit the

free expression of ideas. Judging ideas is not dismissed as unimportant but is simply deferred until later, as a separate step in the process of developing ideas or solving a problem.

- *Avoid ownership of ideas.* All ideas belong to the group. When people feel that an idea is “theirs,” egos can get in the way of creative thinking (and people are likely to be defensive later when ideas are critiqued). When people feel they own ideas they are less willing to allow their ideas to be modified, as in the next rule.
- *Feel free to “hitchhike” on other ideas.* This means that it’s okay — more than okay, it’s encouraged — to borrow elements from ideas that have already been offered and to take ideas already suggested and make slight modifications to them.
- *Wild ideas are encouraged.* Impossible, crazy, totally unworkable ideas may not be where the group will want to end up, but wild ideas often lead someone to think of other more workable ideas. It’s much easier to take a wildly imaginative bad idea and tame it in ways that fit the constraints of an actual problem than it is to take a routine bad idea and turn it into something interesting.

Divergent thinking can be used as part of a larger creative problem solving process (such as CPS, in which each step of the model includes both a divergent-thinking phase, which usually involves brainstorming, and an evaluative thinking phase, in which ideas are compared and judged). It can also be used to aid knowledge acquisition (as discussed in the **Teaching for Creativity and Teaching Content Knowledge** section below). It can also be used alone to build up and exercise divergent-thinking “muscles” — but the nature of those “muscles” is important, and leads us into the key question of the section, **Divergent Thinking and Domain Specificity**: How domain specific are divergent thinking and creativity, and what does this mean for teaching creativity?

CPS

The most widely taught complete model for teaching creativity is the Osborn-Parnes CPS model. As already noted, each step of the model involves a divergent thinking phase followed by an evaluative phase in which problem solvers decide which of the ideas produced should be carried over to the next step in the process.

The model itself has many variations; as its official website notes, “If you search the Internet for “Creative Problem Solving,” you’ll find evidence of many variations, all of which may be traced back to the work that was started by Alex Osborn in the 1940s, developed with Sid Parnes in the 1950s, and nurtured at SUNY Buffalo State and the Creative Education Foundation” (<http://www.creativeeducationfoundation.org/creative-problem-solving/the-cps-process/>). The version described here is typical of the many variants, which differ only in fairly minor details or nomenclature.

1. *Mess-Finding* means being open to experience, freely exploring opportunities, looking at old solutions in different ways, and thinking about things one might like to change (either because the current situation is somehow unpleasant, or because one senses that a tolerable or even pleasant situation could be improved). This is the divergent thinking phase. The evaluative thinking phase of Mess-Finding is the acceptance of some challenge, some situation that one has decided to try to improve.
2. *Data-Finding* is gathering information about the situation. This includes the kinds of things we normally call facts (Who, What, When, Where and How kind of facts), and it also includes impressions, feelings, and other very subjective kinds of information. This is not a search for solutions, but it may involve considerable analysis of the situation. The goal of Data-Finding is to understand the current situation, including its problematic aspects, as thoroughly as possible. After brainstorming produces an abundance of such data, the problem solver evaluates the list he has created to determine which are most important to bear in mind in the next steps of the process.
3. *Problem finding* is a search for the best way to frame the problem in terms of what it is one wishes to achieve. Problems are typically stated in the form of “In what ways might I... ?” or “How might I... ?” because this kind of phrase forces the problem solver to think about where she wants to end up, not how she will get there. As in every step in the process, the problem solver first focuses on a wide range of possible problem statements (using divergent thinking) before narrowing this down to the best such statement (evaluative thinking).
4. *Idea-Finding* means developing and listing a wide variety of possible solutions to the problem statement (divergent thinking), then narrowing down the list to just a few (evaluative thinking).
5. *Solution-Finding* is a continuation of the winnowing process begun in Idea-Finding. The goal is to find a way to evaluate the promising and interesting ideas that one came up with during Idea-Finding. The difference between Solution-Finding and the evaluative part of Idea-Finding is that in Solution-Finding, explicit criteria are developed to evaluate ideas (divergent thinking phase). Then those criteria are applied, and an optimal solution is found (evaluative thinking phase).
6. *Action-Planning* is the final step. It includes looking ahead to assess possible sources of assistance and resistance, implementing the solution, and monitoring progress along the way to determine how well the plan was working and what adjustments might be needed. Sometimes Action-Planning results in new challenges — new messes — which takes one back to Mess-Finding.

Divergent Thinking and Domain Specificity

Domain specificity theory argues that creativity varies by domain and that most of the skills that underlie creative performance in one domain are of little importance in other domains. Just as developing skills and acquiring the kind of content

knowledge that will make one an expert in one domain (e.g., auto mechanics) will have little impact on one's expertise in an unrelated domain (e.g., ballet), so it is with creativity-relevant skills (including, but not limited, to divergent thinking). Developing creativity-relevant skills can only happen domain by domain. This parallels how skill development and knowledge acquisition must be taught in most contexts. Teaching students U. S. history is unlikely to have any impact on what they know about physics (and vice versa). In fact, teaching students U. S. history is not even likely to have much influence on what the students know about other areas of history, such as ancient Japanese history or modern Egyptian history, although there could well be similarities in the kinds of research and interpretations students encounter in this within-domain example. Teaching tends to be very domain specific when it comes to content knowledge, and the same is true (according to domain specificity theorists) of creativity.

Content knowledge is typically taught domain by domain — noting, wherever possible, linkages among domains. Most critical thinking skills must also be learned domain by domain, and creative thinking skills include critical thinking skills. Despite its emphasis in creativity training programs, creative thinking isn't just divergent thinking, isn't just coming up with many possible responses to open-ended problems or opportunities. Creative thinking often requires original and unusual ideas, but it also requires determining which ideas will work, which fit the constraints of the situation, and as such productive creative thinking relies on clear critical thinking. And critical thinking skills tend, like content knowledge, to be largely domain specific.

Here's an example using one of the most widely taught critical thinking skills (and one that is often essential for creativity), analysis. One can teach students to analyze a sonnet, analyze a geometric proof, analyze white light by dispersing it with a prism, analyze tree rings, analyze historical documents for evidence to support or refute a theory, analyze the formal elements of a work of art, analyze a rock strata, analyze computer code, analyze a philosophical argument, or analyze the structure of a musical composition, but one cannot simply teach "analysis" as a general skill and expect students to apply it in all areas. Teaching analysis means teaching analysis in many different domains, with little anticipated overlap.

So it is with all of the thinking skills that underlie creativity, including divergent thinking. Just as we can lump together many very different skills under the label "analysis," even though they are actually many very different domain-specific skills, the same is true of divergent thinking. Different kinds of analysis, like different kinds of divergent thinking, may have a similarity when viewed, as it were, from the outside. But from the inside — from the perspective of the thinker — they are quite different. Being able to do one kind of analysis or one kind of divergent thinking does not mean one can do other kinds of analysis or divergent thinking. If a teacher's primary goal is to promote student creativity in a single domain (e.g., in a creative writing class), then focusing one's teaching activities on that domain is most appropriate. If the goal is to promote student creativity in multiple areas, however, it is essential that the creative-thinking exercises (including divergent thinking exercises) use content from a wide range of domains.

This domain specific creativity training effect has been shown in experimental divergent thinking training studies, where one domain has been targeted, as well as in descriptive studies that have look at correlations of creative performance across domains (Baer, 2016). For example, in a study in which middle school students received divergent thinking training with only poetry-related exercises, students later creative performance was significantly greater when writing poetry, but not when writing short stories (Baer, 1996). The content of the poetry-related divergent thinking training exercises included:

- * finding words that sound like a given word (rhyme and assonance)
- * finding words that have the same sound as a given word (alliteration)
- * finding words that could stand for or in some way represent a given thing or idea (metaphor)
- * inventing words or descriptions of things that are richly suggestive of other things (images)

The exercises were designed to increase fluency, flexibility, originality, and elaborative skill in each of these areas.

These results are in line with the results of studies that have simply measured creativity across domains. There are strong within-domain correlations, showing that students who show creativity within a domain on one occasion are likely to do so on future occasions. In striking contrast to this within-domain consistency, however, creative performance in one domain tends to be not at all predictive of creative performance in other domains. There are some students who are creative in multiple domains, of course, but no more so than chance would predict. For example, in one especially large study with multiple tasks in each of the two domains assessed (creative writing and art), the 16 within domain correlations were consistently large and statistically significant, but not one of 20 the cross-domain correlations reached statistical significance (Conti et al., 1996).

What does this mean for teaching creativity? The answer is both simple and hard: Teachers must teach creativity in every subject area in which they want to help their students become more creative. Teaching for creativity in drawing, for example, will impact students' creativity in that area in positive ways, but will generally have no impact on their creativity in science, language arts, or other areas. Teachers cannot teach creativity generically; they must teach it, promote it, and nurture it domain by domain.

It should be noted that the question of the degree to which creativity is domain specific is an area of active research. No one doubts that there is a significant domain specific aspect to creativity; the open question is whether there is also a domain general aspect, and, if so, how significant domain generality factors might be. But for those who wish to teach for creativity, there is a simple choice. There can be no loss in assuming even total domain specificity, whereas assuming domain generality takes on considerable risk. This is because even if domain specificity is one hundred percent false, the creativity trainer who assumes domain specificity

will be just as effective as he would be if creativity were entirely domain specific, whereas the trainer who assumes domain generality could (if creativity proves to be largely domain specific, as research increasingly suggests) could be wasting much of her students' time. If creativity is domain general — in which case it wouldn't matter the content of the training exercises the teacher uses — then whether the exercises were drawn from multiple domains (as domain specificity encourages) or all from the same domain would have no influence on the outcome. The result for students would be the same.

But if creativity is domain specific, then the content of the training exercises matters very much. A trainer who assumed domain generality could choose content from any domain, including using all content from just a single domain (as in the [Baer, 1996](#) study described above). This would result in a creativity training effect limited to just that one domain. Therefore, unless one is absolutely certain that creativity is primarily domain general — a conclusion that seems less and less likely to be true — then teachers who wish to develop their student's creativity are well advised to assume domain specificity.

It is important to understand that domain specificity of creativity doesn't mean that multidisciplinary and interdisciplinary thinking and problem solving can't be done. Teachers need to teach for and encourage such thinking. But interdisciplinary thinking and problem solving require both expertise and thinking skills (including creative thinking skills) from multiple domains, each of which must be developed and acquired domain by domain. Creative interdisciplinary thinking and problem solving will require going beyond what one understands and can do in one domain — and often synthesizing ideas, approaches, and techniques from multiple domains — but such thinking is impossible without solid grounding in the content and creative thinking skills of the various domains that one's interdisciplinary efforts hope to bring together.

Intrinsic Motivation

It will surprise no one to learn that people tend to be more creative when they do things they find interesting, personally fulfilling, and meaningful. Teachers hardly need to be convinced that intrinsic motivation is a good thing: there are already so many other reasons that teachers want to promote intrinsic motivation in their students that adding "Boosts Creativity" to the list just seems like icing on the cake. This is surely one way in which teaching creativity fits hand-in-glove with what teachers would want to do anyway.

The intrinsic motivation story quickly becomes complicated, however. Intrinsic motivation competes with extrinsic motivation, and in this competition, extrinsic motivation tends to win. Extrinsic constraints (such as doing things in order to earn a reward or anticipating evaluation of one's work) tend to drive out intrinsic motivation ([Lepper and Greene, 2015](#)). This "hidden cost of reward" means that when teachers offer students rewards (or when they promote extrinsic motivation in other ways) they may be inadvertently undermining intrinsic motivation (See Motivation).

The research of [Amabile \(1983\)](#), [\(1996\)](#) and et al. demonstrated how extrinsic constraints can be detrimental to creativity. In more than a score of experimental studies with participants ranging in age from kindergarten through college, she showed that offering rewards and having students expect that their work will be evaluated tends to decrease their creative performance, and this effect that is especially strong among adolescent girls ([Baer, 1997b, 1998a](#)). There may be conditions under which this effect does not apply ([Eisenberger and Shanock, 2003](#)), but in general the effect is both real and of considerable strength. This presents a significant challenge to teaching creativity.

There are times when teachers can reduce the salience of extrinsic constraints, or even remove them entirely. For example, one can sometimes assign students the task of creating something (e.g., a short story, a poem, or a work of art) with the understanding that it will not be graded or evaluated in any way. For such an assignment students need to do *something*, but as long as they turn in something— anything — they get full credit. Some students will take advantage of this, of course, and do as little as possible, but others will make good use of the freedom that such an assignment gives them. This kind of assignment is sometimes a genuine possibility and should be utilized.

But much of students' work must be evaluated in order for students to learn and develop skills. Feedback of any kind — even positive feedback — counts as evaluation and will negatively impact creativity. This is a cost that cannot be wished away, because without feedback, students cannot acquire and hone the skills they need both for creative and uncreative thinking and problem solving. Teachers can do things to minimize that negative impact, and they can do other things to try to increase students' intrinsic motivation, while at the same time understanding that their actions will necessarily, at times, increase students' extrinsic motivation at the expense of students' intrinsic motivation and creativity.

Although the positive impact of intrinsic motivation on creativity and the negative impact of extrinsic motivation *appear* to be domain general factors influencing creative performance, this is misleading because intrinsic motivation itself is very domain specific. Consider this parallel claim: One could say that practice is a domain general factor in skill development. Yes, but practice playing a trombone won't increase skill in solving differential equations; the two are unrelated activities, and the fact that one needs to practice both to develop skill is an almost trivial similarity. In the same way, intrinsic motivation to write poetry and intrinsic motivation to do woodworking are unrelated motivations, and having one of the two kinds of intrinsic motivation will affect creativity only in that domain. In both the case of intrinsic motivation and the case of practice, the suggestion that these are domain general factors is true only in the most superficial way. What is important is the content, whether one is talking about intrinsic motivation or practice. Students aren't uniformly intrinsically or extrinsically motivated; they find some activities highly interesting and meaningful and others less so. Increasing intrinsic motivation for studying history cannot be expected to have any impact on

intrinsic motivation to understand algebra (or vice versa). As with teaching divergent thinking, teachers need to promote intrinsic motivation in many different domains.

Teaching for Creativity and Teaching Content Knowledge

Most teachers want to help their students become more creative thinkers. They also want to help students acquire content knowledge and skills of many kinds. Sometimes it can seem as if these two kinds of goals — creativity and content — may be in opposition, especially in an era of teacher accountability. This apparent conflict is, however, in many ways an illusion.

There are indeed areas in which the two goals can sometimes conflict, as has already been noted in the previous section: extrinsic constraints are often needed and helpful in promoting the acquisition of content knowledge and skills, whereas extrinsic motivation often has a negative impact on creative performance. There are also the time constraints of schooling: there is simply not enough time to do everything, and many teachers see teaching for creativity taking time away from teaching things (such as those outlined in the Common Core State Standards) that will be tested.

But that is just part of the story. Creativity and content knowledge — and teaching for creativity and teaching content knowledge — are also mutually supportive in many ways. Creativity requires both content knowledge as well as many kinds of basic skills (e.g., one cannot be a creative historian without knowing a lot of historical content, or a creative mathematician with first acquiring a great deal of mathematical skill). And two of the best ways to acquire content knowledge and develop skills are by thinking about that content knowledge deeply and creatively and by employing those skills in solving real problems.

The possible conflict between teaching for creativity and teaching for content is part of a long-standing dispute about how learning content and learning to think effectively might be related. It should be clear, however, that both critical and creative thinking rely heavily on knowledge. Failures in critical thinking are often the result of faulty premises, and failures in creative thinking are often similarly the result of a lack of domain-specific knowledge. Both critical thinking and creative thinking are supported when students learn the concepts, facts, and skills that make up a rigorous curriculum like the Common Core State Standards. The development of creative thinking therefore requires a strong content-based curriculum.

Content knowledge is of course extremely domain specific. The fact that creativity in most domains requires significant amounts of domain specific content knowledge is no more evidence of a domain general factor than the fact that skill development requires practice is evidence of a domain general factor, as discussed in the [Intrinsic Motivation](#) section. In each case the relevant knowledge or skill is very domain specific.

Looking at the supposed conflict between teaching for creativity and teaching for content knowledge from the opposite perspective, what can teaching for creativity do to promote the kinds of skills and knowledge required of the Common Core (or other curricula)? One of the most effective ways to learn content knowledge is to think about that content in some way — to become actively engaged with the concepts, understandings, facts, skills, or whatever content one wishes to learn. Learning requires that students create meaning — that they construct knowledge — based on their experiences and how they make sense of those experiences. The important kind of engagement with content is active *cognitive* engagement, such as that of creative or critical thinking. Meaningful learning is more effective and more long-lasting than rote memorization of poorly understood or totally uncomprehended facts. And although thinking creatively about content isn't the only possible kind of meaningful cognitive engagement, it is one of the most powerful. There is therefore more potential synergy between teaching for creativity and teaching for content knowledge than there is opposition ([Beghetto et al., 2015](#)).

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Teams[☆]

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Teams

Teams are groups of individuals who work together to accomplish a task or series of tasks. Many tasks are accomplished by ad hoc teams brought together temporarily to accomplish a task in a specified period of time such as committees or task forces. Other teams are part of organizations and work together over an extended period of time on a variety of related tasks. One of the key characteristics is that teams are interdependent – that is team members depend on one another for the successful completion of their goals. This often presumes that team members vary in their expertise and have to effectively coordinate their activities to optimize their performance of tasks including creativity tasks. Although teams are often embedded in organizations and may have a history of working together, much research on creative teams and groups involves interactions on specific tasks during limited periods of time in laboratory settings. This research is similar in scope to that done under the label of group creativity. Studies of longer term creative teams are often in the form of case studies. Much of the research on team creativity involves the use of self-report measures of the processes and the outcomes. This is potentially problematic in that the use of such a methodology may not reflect what is actually occurring in teams. Studies of work teams in organizations that use objective measures are relatively rare. Most studies using objective measures of creativity involve laboratory studies of group creativity. Of course, these laboratory studies may have limited applicability to the understanding of creativity in long-term and specialized teams. However, there is considerable overlap in the findings on innovation in work teams and creativity in laboratory groups. Thus, the results from both areas of study appear relevant to understanding the creativity of teams.

Creativity Versus Innovation

The literature on creativity in teams tends to use the term innovation rather than creativity. This may in part reflect a bias in terminology by researchers in organizational behavior who are trying to appeal to the business world. The world of business and industry is interested in innovation or the development of new products or services that are useful and have a positive economic impact. Just because a product or idea is creative does not mean it is going to be useful. So the criteria of usefulness and feasibility are important ones. However, innovation is also often reserved for implementation of ideas generated during a prior creative

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phase. Creativity is seen as an exploration phase of generating novel alternatives or solutions, and innovation as a phase of exploiting the ideas toward some useful end. Although it is presumed that different principles govern the different phases, the literature suggests that many of the same factors that influence creativity also influence innovation. Successful exploitation or implementation of ideas also requires creative thinking. This thinking may not be as radical or divergent as that in a prior exploration phase but is creative nonetheless. Moreover, in many studies of team innovation, there is not a clear distinction between the processes of exploration (the initial generation of a range of ideas) and exploitation (selection and development). Thus this summary of team creativity literature will ignore the innovation/creativity distinction, except in the discussion of the phases of the creative process.

Basic Processes

Team creativity involves social interaction and collaboration. That is, team members engage in a variety of social activities in order to complete their tasks. In the early stages they may have discussions about goals, task distribution, coordination, feedback systems, and compensation. If they are involved in a creative task there is at some point a process of sharing ideas about a particular issue or problem. This may be followed by some evaluation of the different ideas and possible implementation of the most promising ideas. These processes may be repeated in different sequences during the life of the team. The focus of this entry is on the creative or ideational phases of the team process since there is a significant literature on this issue. The initial planning and later innovation stages may involve somewhat different processes.

Theories of collaborative creativity have recognized both the social and cognitive forces that play a role. Some theories have emphasized the cognitive aspects of collective ideation. As individuals share ideas they need to search their memory or knowledge base for relevant information or ideas. When these ideas are shared in a team, they may stimulate others to think about related issues. So collective sharing of ideas should increase the range of topics or issues that are discussed and lead to mutual stimulation of ideas. Of course this requires careful attention to the shared ideas and thoughtful relating of these ideas to the knowledge or memory base of each team member. This may be facilitated by some intermittent opportunities to reflect on the shared information.

At the same time, the idea sharing process may provide a social stimulus for increased effort as team members compete in trying to come up with more and better ideas. This would be particularly true if there is some degree to which individual group member contributions can be identified and recognized. It also appears important that team members function effectively to seek help and give help at critical times in the creative process. This process needs to be reinforced by positive experiences in the group and a supportive organizational culture. However, the social context can also hinder the creative process because of concern about deviating from normative group expectations and there may be a tendency for group members to focus on areas of agreement rather than their potentially unique perspectives. A fundamental process in team creativity is the communication among team members and with other teams. This process appears to be strongly related to team creativity, although there is some evidence that too much communication can be detrimental. A high level of communication may distract from one's focus on the task or may involve task-irrelevant as well as task-relevant information. Irrelevant information may make it more difficult to focus on the essential aspects of the task. A key task for creative teams is to process the shared ideas, elaborate on them, and integrate them into a high quality innovation. This requires effective integration of the diverse knowledge bases present in the team.

Factors Influencing Team Creativity

Much of the research on team creativity has examined the factors that influence the degree to which teams, especially work teams, develop creative ideas, or innovations. The basic presumption is that the composition of the team, the characteristics of the team members, and the task and social context of the team will influence these outcomes. This presumption is consistent with an input–process–output perspective of teamwork. This perspective focuses on the person, team, and context characteristics that influence the team processes that in turn affect the various outcomes such as performance, satisfaction, and team viability. This framework provides a useful means for organizing the presentation of the major findings. This entry will summarize the major factors that influence the team processes and the resultant degree of creativity.

Team Member Characteristics

To a large extent the innovativeness of a team depends on the personal characteristics of the team members. The higher the creative ability of the individual members, the higher will be the creativity of the team. Teams whose members who are open to new experiences, extraverted, have a promotion focus (oriented to achievement rather than safety), and have an ability for divergent thinking are more likely to be creative. It also is beneficial if team members have a positive attitude toward the team. High levels of collective creative self-efficacy also seem to be related to higher levels of team creativity. Such team level self-efficacy likely requires prior shared experiences of creative success, and so teams that already have a composition that is favorable for creativity are likely to develop increased confidence in their creative ability, further enhancing their creative output. The teamwork literature suggests

that it is important for team members to have a range of team-relevant skills such as shared leadership, coordination, performance monitoring, and adaptability.

Although having more members with certain personal characteristics increases the potential creativity of the team, it may also be beneficial to have a mixture of team members with somewhat different characteristics. This may be particularly important as the team goes through different phases of the creative process. During initial divergent ideation sessions, having group members who are able to come up with a lot of creative ideas will be beneficial. However, in later idea development, elaboration, and implementation phases, group members who are motivated to persist in the difficult task of coming up with a solution that deals with various technical, financial, and social constraints may be most impactful. Group members who are high in conscientiousness, agreeableness and prevention focus (concerned with attaining security and avoiding loss or harm) may play critical roles in these later phases. The impact of team composition also depends on a variety of group-level and contextual factors such as variation in status level of team members, degree of group interdependence and the extent to which the context allows for or constrains the full expression of individual differences.

Team Size

Teams can vary greatly in their size, depending in part on their scope and the complexity of their task. Complex and multifaceted problems may require a wide variety of expertise on the team. Since larger teams are more likely to consist of members with diverse perspectives and skills, it is not surprising that larger teams are associated with more innovation. However, large teams may also have drawbacks since they may reduce the extent to which individual members feel accountable or important to the rest of the team. Thus there may be some loss of individual motivation. Moreover, in large team meetings it may be difficult for all team members to effectively contribute because they have to share the available discussion time. It appears that the ability to express one's ideas as they occur is important in one's ability to generate a flow of ideas. This interference effect due to having to coordinate the expression of one's ideas in the group is known as production blocking. Therefore, it may be best to keep the team as small as possible while still providing the range of expertise needed.

Diversity

One of the benefits of bringing team members together on a creative task is to take advantage of their diversity. Diversity represents the variation in personal characteristics of team members. Team members can vary in their demographic characteristics such as race, gender, age, tenure in the organization, personality, status, values or beliefs, knowledge, experience, and expertise. Each of these characteristics may make interacting with other team members interesting, but research has found that most people prefer to interact with people who are similar to themselves. So there may be a social bias to homogeneous groups or teams. In diverse groups, group members may be somewhat uncomfortable in sharing their ideas or perspectives since they may conflict with those of other group members. Groups often like to gain a consensus based on common perspectives, as seen in cases of groupthink in decision-making groups. So individuals in groups may be more responsive to an idea which is familiar rather than one that is different or unique. As a result most reviews of the literature have found that overall diversity is not related to enhanced performance in groups or teams.

Diversity in knowledge or expertise (functional diversity) does appear to be related to enhanced team creativity. The effects for demographic diversity are more inconsistent. Effective tapping of this type of diversity requires that group members have a positive disposition or attitude to interacting in diverse groups and that they are either intrinsically or extrinsically motivated to take advantage of the diverse ideas or information shared by the team. Intrinsic motivation requires a strong personal interest in the creative activity and learning from others. Extrinsic motivation involves social or organizational incentives (such as financial incentives or prizes) that motivate team members to work hard. Under such conditions team members may carefully process or elaborate the shared ideas and information and come up with potentially innovative ideas based on the diversity of perspectives present in the group. However, demographic or value diversity may not have much influence on creativity unless it is relevant to the team task. Thus the development of an advertising campaign for diverse populations may benefit from demographic diversity, but this type of diversity might not have a positive influence on the development of some innovation in healthcare or technology. This type of innovation will probably require people with diverse expertise or experience relevant to that issue.

Interdisciplinary Teams

The research on diversity suggests that interdisciplinary teams should be helpful to creativity. Interdisciplinary teams consist of individuals who are experts in different areas relevant to some task or goal. In science this may involve scholars from different disciplines, in technical fields they may consist of people with different technological expertise, and in work settings they may involve employees from different departments or divisions. The presumption is that for broad problems or initiatives, a broad range of expertise or knowledge will be required. Teams that include individuals that represent these divergent perspectives or areas of expertise will be better able to solve complex problems or come up with creative solutions or ideas. One can make a distinction between multidisciplinary and interdisciplinary teams. Multidisciplinary teams involve team members from different disciplines coordinating their efforts to achieve a common goal. This type of collaboration primarily involves the use of complementary areas of expertise required to accomplish a goal. Interdisciplinary teams require a higher level of collaborative interaction that involves the

actual integration of knowledge or expertise to create new concepts, theories, techniques, or approaches that go beyond what was possible in any one of these disciplines alone. Members of interdisciplinary teams have to effectively coordinate their various contributions to achieve the group goal. They also need to understand each others' areas, and this level of enhanced mutual understanding may allow the team to reach new levels of technical development.

Achieving mutual understanding in interdisciplinary groups may be difficult. Groups tend to focus on areas that they have in common, in part because such common understandings have obvious validity to the team members and provide a sense of cohesion. It may be difficult for team members to understand each other's unique areas of expertise unless they have broad training or expertise. With the increasing specialization in all areas of science and technology, few have the time or inclination to develop the broad expertise to effectively understand and build on diverse areas. However, it may be sufficient if team members have the basic knowledge to understand the exchanged communications. An important issue for future research is to determine the role of depth and breadth of expertise in the creative potential of interdisciplinary teams.

Interdisciplinary teams appear to function best when the context or relationships among team members enhances the communication processes. So teams whose members are located close to each other physically or who are in the same organization tend to be more effective than those who are at different locations. Also, it appears to be beneficial if the team members have some degree of collaborative 'closeness' in that they communicate frequently and have strong interpersonal bonds. This is most likely to occur if team members have considerable experience in working together effectively. In fact, the team members who are at the center of the information flow and are aware of the distribution of expertise in the team tend to perform best. Smaller interdisciplinary teams seem to be more innovative than large ones, presumably in part related to more effective information exchange in the smaller teams.

Team Experience Versus Turnover

Teams that have spent some time working together are likely to function more effectively than those that do not have such experience. Such teams can develop shared mental models (common understandings among team members about team composition, goals, and tasks), learn who knows what (transactive memory) and how the team will work together to accomplish its goals. Such teams may also develop the ability to reflect on their processes and make appropriate adjustments (reflexivity). However, in most teams members change periodically. Loss of members who have key skills or knowledge can be very detrimental to the functioning of the team. The team can also lose some of its cohesion and may have to redevelop its transactive memory systems. Although research on the issue of turnover in teams is limited, there is some research indicating that periodic changes in group members can enhance creativity. The new perspectives provided by a new member could stimulate other team members to think more deeply about issues or reevaluate their ideas. However, in reality this effect will also depend on whether this team member is a creative person who asserts him or herself effectively as a new member of the group. Newcomers in groups may have to first establish social ties with other group members and adopt the group norms before they can begin to have an innovative impact on the other group members. The impact of contributions by newcomers to the team is also enhanced if they share a common identity with the group (i.e., they share a common goal, values or personal characteristics). However, this positive effect may only occur if the newcomer makes high quality contributions.

Conflict

When team members share diverse perspectives, there may be conflicts. Conflicts in teams are generally associated with negative feelings, especially if the conflicts are social in nature. However, it appears that cognitive conflicts that involve differences in perspectives can stimulate creativity. Such conflicts can lead participants to reevaluate their own perspectives, especially if those presenting the conflicting perspectives are persistent and do so in a way that is not offensive to the team. In fact, exposure to conflicting perspectives may increase the tendency to divergent thinking and affect creativity on tasks totally unrelated to the setting in which the conflict was experienced. Apparently, the experience of divergent perspectives increases the extent to which a person is willing to consider alternative perspectives in general. Even though cognitive conflicts can increase creativity among group members, overall performance of the group may not increase. Cognitive conflicts may have negative emotional effects which can inhibit the types of interactions required for the overall effective performance of the team. Thus it is not surprising that a number of studies have found that moderate levels of conflict may be optimal for team creativity. However, it is also important for groups to have a collaborative atmosphere and feelings of interpersonal trust or psychological safety. This may require team leadership that helps teams to develop these characteristics.

Team Climate: Safety and Cohesion

It is important for teams to have a positive orientation toward creativity. That is, they share positive beliefs, expectations and norms about innovation. One of the key factors in fostering a creative atmosphere in a team is psychological safety. This is the extent to which group members feel that they can express their thoughts and ideas without fear of negative reactions from their fellow team

members or the organizational leadership. When participants have this kind of feeling, they are more likely to share their unique and possibly controversial ideas. However, some reviews of the literature suggest that psychological safety may be a somewhat weak predictor of innovation. This may be in part because it needs to be balanced with appropriate levels of accountability. In an 'anything goes' environment team members may be tempted to loaf and may drift in their task focus. Some degree of task structure and specific goals may be needed to keep team members on track. Some time or task constraints, requirements or goals may help motivate higher levels of team creativity in psychologically safe contexts.

In a similar vein, research has found when there is an element of trust among the participants involved in a creative enterprise, creativity is more likely to flourish. Trust represents the feelings that others care about one's well-being and one can count on their support even for the 'risky' activities that may be involved in creative work. In fact, the emotional support for one's creative activities from both fellow workers and from family and friends are important for enhancing creative performance. So team members need to trust one another and to support one another in their creative activities. This does not mean that all the innovative ideas expressed have to be accepted or carried out. However, team members should feel that their creative ideas will get a fair hearing from the team.

Another important source of support is the organization within which the team is embedded. Unless the organization and its leaders support creative activities by the team, the team will not have an incentive to be creative and will not feel comfortable in sharing novel ideas for improving the organization and its various projects. A psychologically safe environment may lead to positive interpersonal feelings that are an important component of group cohesion. Group cohesion is the extent to which group members are attracted to the group and its goals. Cohesion can consist of feelings of interpersonal liking, task commitment, and group pride. Not surprisingly these factors have been associated with enhanced performance in groups and teams. Cohesion should enhance creativity since team members feel comfortable with one another and are motivated to achieve the team goals. They should not be inhibited in sharing their unique perspectives and should work hard to integrate these perspectives to come up with a novel solution. Cohesion may take some time to develop, so positive effects may not be evident until the team has been together for a period of time. However, long-term teams that are cohesive may not necessarily be optimal for creativity. There may be pressure to maintain the positive team feelings and to act in accord with the group norms or expectations. This may inhibit the sharing of novel perspectives that are contrary to the dominant views of the team. In these settings it becomes even more important to insure openness to diverse or contrary perspectives or psychological safety. It may also be important to balance team cohesion with some degree of membership turnover and active contacts with experts outside the team.

Task Structure

Creativity is generally seen as an unstructured activity in that the participant should be as unconstrained as possible by reality, task structure, and time. There is in fact considerable evidence that periods of time without distractions or other demands can facilitate creative achievements. This is particularly true for individuals who have a strong intrinsic motivation for their creative pursuits. Research indicates that it is important for such individuals to have a high degree of autonomy or freedom in their task activities. Increasing task constraints and applying external pressure for task achievement may in fact reduce such intrinsic motivation and creativity. Autonomy also tends to be important for teamwork. Much research has shown that teams that are self-managing, in that they have a choice in their tasks, task processes, and team procedures, tend to function better than those that do not have such autonomy. Similarly, team autonomy appears to be related to enhanced creativity.

Although autonomy and freedom appear to be important for creativity, some degree of structure may also be helpful. It helps to have clear goals and objectives. The team can collaborate in setting such goals, but there may be some tendency to set 'attainable' goals rather than challenging goals to avoid the experience of failure. It should also be clear that the goals are for creative production. If the organizational context provides psychological safety, group members may feel it is 'safe' to select ambitious goals. These goals can vary in the extent to which they emphasize originality and feasibility or applicability. Although mutual goals of innovation and feasibility can be seen as conflicting, some research indicates that such dual goals can in fact be quite effective in promoting both originality and the generation of feasible products or ideas.

Although external pressures or incentives can reduce creative motivation, this is not inevitably the case. When these external forces are seen as external control, it may lead to reduced intrinsic motivation. However, when the external forces are perceived as confirming one's competence or enabling one to do an intrinsically interesting task, they may actually increase overall motivation. Competition within the team or with other teams may be one such external motivator. Performance feedback or the provision of challenging goals may have similar positive effects on the creative production of teams. In addition to having some 'directive' social contexts, the task context is also important. In particular it appears that it is useful to have some degree of task structure. Breaking a task into its subcomponents, explicitly defining the problem, providing brief breaks during long idea generation sessions, and providing clear instructions about how to efficiently share are important in increasing the number of ideas generated.

Therefore, in order to increase team creativity, intrinsically motivated group members should be given a high degree of autonomy and time to perform the task without distraction. The development or provision of clear, challenging but attainable goals, performance feedback, and intra- and intergroup competition can increase motivation without decreasing intrinsic motivation. Although many see creativity as an unstructured activity, certain procedural guidelines can improve team creativity.

Training

Although there is considerable research on training creativity and training teams, there is very little systematic research on the training of group or team creativity. While experience in creative groups may be beneficial, it may also lead to the development of task procedures which are not beneficial to enhancing team creativity (such as the amount of time spent in group interaction). Although the creative process in a particular team may appear to be quite successful, team members typically do not have a clear basis for assessing how effective they have been. Research that used control groups as a reference point found that providing groups training that includes practice and the reinforcement of efficient sharing strategies increased the quality of ideas generated.

Leadership

It is typically presumed that groups need leaders for effective performance. There is a massive literature on leadership in general and considerable data on leadership for groups. Group leaders may be external such as bosses who assign tasks to teams. Teams may also have internal leaders who are actually members of the group. These leaders may be assigned, elected, or may simply self-select to this position in the absence of any clear structure. In general, it appears that team creativity can be enhanced by leaders that provide a clear vision or goals, provide support for innovative activities, and develop a climate in which team members feel it is safe to explore creative directions. Therefore it is not surprising that some studies found that a transformational leadership style that involves providing individual mentoring, encourages challenging old assumptions, and inspires sharing their vision and setting high expectations is sometimes related to team creativity. However, it also appears that both task oriented leadership (structuring the task, setting goals, directing interaction) and relationship or participative oriented leadership (concerned with good relations and encouraging personal initiative) can enhance team innovation. Participative leadership may be most helpful in the early idea generation stages of the innovation process while the task oriented leadership may be more helpful in the implementation phase. Similarly, there is evidence that ambidextrous leaders who are able to vary their interactions with the team to align with the needs of the different phases are optimal for team innovation. It may also be useful to have a shared leadership in which leadership changes depending on the phase of the process (exploration or exploitation) or the type of expertise needed as in the case of interdisciplinary teams.

Teams may also exercise 'self-leadership' if they have considerable autonomy. Such leadership may take the form of shared leadership with different members leading different aspects or phases of the task. Such shared leadership requires effective skills in knowing how to allocate task components and when to switch leaders. Teams will need some extensive experience or training to develop such adaptive routines. This may involve 'coaching' group members to optimize motivation, task allocation, and appropriate alignment of task routines with task requirements.

Interteam Creativity

Many teams work in organizational contexts in which they interact with other teams. Such interaction can enhance creativity both at the level of the teams and the organization. Exchange of ideas among teams may enhance their creative potential by increasing the diversity of perspectives. If there is some degree of competition among the teams for the development of innovations, team members may make greater efforts to excel in their creative efforts. However, there are also a number of factors that limit interteam creativity. There may be strong in-group biases which may limit the extent to which group members exchange ideas and build on such 'outside' ideas. An important factor in facilitating interteam creativity is the extent to which there exist communication networks among the members of different teams. This is particularly true when there are knowledge gaps or structural holes among the teams. When teams have non-overlapping knowledge bases there is likely to be a greater benefit of exchange of ideas among the teams. However, it is important for team members to be receptive to such information and overcome their intergroup biases. In the broader teams literature there has been much focus on multi-team systems which require coordination among different teams in organizations. This research also discovered many factors that inhibit effective coordination among teams. Even when these teams have shared goals, the inhibiting factors can still play a role. Effective interteam processes will likely require effective leadership and team training.

Electronic Creativity

With the increased availability of digital means of communication such as email, cell phones, computer networks, and the internet, there is much potential for creative collaboration by electronic means. If group creativity is construed primarily as a process of mutual cognitive stimulation, electronic communication should be as effective as face-to-face communication. In fact, research on electronic brainstorming, in which participants share ideas by means of various group information sharing systems, has found that electronic exchange of ideas can be more effective than face-to-face exchanges, particularly for large groups. This may reflect the fact that electronic exchanges avoid the production blocking inherent in face-to-face settings. One potential disadvantage of electronic exchanges is that it may be more difficult to build cohesion when the interacting members are working from distant locations.

Interpersonal ties may be important in motivating interactions among group members and may facilitate understanding of each other's ideas. Electronic interactions also vary in the richness of interaction modalities. Some may be limited to written exchanges of information while others may involve visual and auditory interactions through the use of video technology. Richer technologies may allow for more effective communication of meanings since they provide for the exchange of various linguistic and paralinguistic cues.

Summary

Team creativity is influenced by a range of cognitive and social factors. Team members need to be highly motivated and to carefully process the shared information or ideas in order to develop creative products. Teams need both autonomy and some degree of structure and goals to function at a high level. A psychologically safe environment, participative or transformational leadership, and training appear to facilitate creative team performance. Diversity, conflict, and turnover of membership can both facilitate and hinder creativity. Electronic exchanges of ideas among team members can be quite effective.

There is no simple recipe for creative teamwork. Many of the factors discussed in this entry can have both positive and negative effects depending on their level or other factors. In general there seems to be support for a sort of 'balance' perspective. Teams should be large enough to do the job, but as small as possible. Some degree of diversity, conflict, and turnover can increase creativity, but too much will backfire. Psychological safety and cohesion are important, but too much may make the team members too comfortable with the *status quo*. A high degree of autonomy may motivate creativity in teams, but without some degree of structure, external goals and effective leadership, the team may not accomplish much. Some degree of virtual interaction among team members may facilitate the exchange of information and ideas, but face-to-face sessions may be needed to deal with more complex problem solving and decision aspects of the creative process. So organizations that foster teams will need to be sensitive to balancing these various dimensions to optimize the creative performance of their teams.

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Technology: Computational Creativity

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The Agenda of Computational Creativity

When Herbert Simon wrote to George Miller on April 30, 1957 claiming that creativity was no longer “as mysterious and inexplicable” as some made out (Herbert Simon Papers, Carnegie Mellon University Archives, Pittsburgh, Pennsylvania), he was riding the wave of success he and Allen Newell had achieved with their computer program Logic Theorist (LT) (Newell and Simon, 1972) which marked the proper beginning of artificial intelligence (AI). A few years later Simon and his co-investigators went on to suggest that human creativity is a kind of computational phenomenon (Newell et al., 1962). This belief, that computational models offer a means of explicating creativity, was an early expression of what, decades later, Jeanette Wing (2006) would call *computational thinking*: the idea that understanding human behavior can be influenced by comprehension of the behavior of computational artifacts. In claiming that human creativity is a computational phenomenon, Newell et al. were indulging in a quintessential form of computational thinking.

Of course, this begs the question: If computational modeling of creative processes could help us understand human creativity, then what is to be the foundation, the inspirational source, for constructing computational models? The only option is human creativity itself, for that is all we have to go on: any discussion of creativity, whether of humans, animals or machines is inevitably and ultimately anthropocentric. This suggests a kind of iterative situation in which human thinking about creativity influences computational modeling of creativity which in turn influences (and presumably enhances) the understanding of human creativity.

Computational thinking about creativity, thus has two distinct faces: on one side, is the problem of constructing computational artifacts (or systems) that manifest creativity (in some sense); on the other, is the problem of eliciting insight into human creativity from such computational models. In recent years the first project has come to be called *computational creativity* — which is the topic of the present article; but as noted, the issue of human creativity can hardly be avoided.

The agenda of computational creativity is a direct derivative of the agenda of AI. The broadly accepted view is that AI's concern is the study and construction of computational systems that exhibit behavior that would be deemed ‘intelligent’ if performed by human beings. Likewise, the concern of computational creativity, broadly stated, is the study and construction of computational artifacts that exhibit behavior which would be deemed ‘creative’ if manifested by human beings (Lamb et al., 2018).

This immediately raises two questions: What is considered to be ‘creative behavior’? And who decides ?

Creativity as History Making

As many creativity researchers have noted (see, e.g., Buchanan, 2001), there is much ambiguity and disagreement about what it means to be creative. The first task at hand, then, is to abstract from these multiple perceptions of creativity and capture in some reasonably uncontroversial fashion the *intuitive* idea of creativity.

Before proceeding with this task two useful terms need to be introduced. First, the term *artifact* will refer to any non-natural thing. This may be material (e.g., a sculpture, a building, or a scientific instrument), abstract (e.g., a mathematical theorem, a design or a philosophical idea) or hybrid (e.g., software). Second, the term *artificer* will mean the producer of an artifact. In the realm of human creativity artificers are, of course, persons, while in the context of computational creativity artificers happen to be artifacts.

Armed with these terms the following is proposed: *To be creative is to make history*. More precisely, an artificer is creative if, in producing an artifact she (or it) makes history.

This *historicalist* perspective originated with Margaret Boden (1991) who identified two kinds of history-making. One is when an artificer produces an artifact that is original with reference to the artificer's *personal* history. Boden called this *P*-creativity (*P* for

personal or psychological). Others may have created the same artifact before but this does not dilute the artificer's personal cognitive achievement.

Boden's second kind of history-making, which she called *H*-creativity ('H' for historical) is when the artificer produces an artifact that is original with respect to *all* of past history, that is, with respect to all of time preceding the time when the artifact was created.

But the artifact's originality must not be conflated with mere novelty. The artifact must be valuable or significant in some sense. In the realm of *P*-creativity this significance may arise because of the difficulty of the problem which gave rise to the artifact. In the realm of *H*-creativity, an artifact's value or significance may lie in its surprisingness; or because the artifact resolves a long-held dilemma; or because it falsifies a current theory or belief; or, most significantly, it is perceived to have *consequences* that may shape or have shaped the future history of the relevant domain.

This last situation, referring as it does to future time, suggests a historicity distinct from the realm of *H*-creativity. The present writer (Dasgupta, 2019, pp 28–31) referred to this as *C*-creativity ('C' for consequential). This is manifested if one can discern an epistemic connection between the artifact so produced (say at some point of historical time *T*) and one or more artifacts produced at some later time *T'*. That is, the knowledge embedded in the earlier artifact serves, at least in part as an input to the production of later artifacts. As two examples consider Picasso's painting *Demoiselles d'Avignon* (2007) which gave rise to Cubism, a painterly style (an abstract artifact), and the invention of the stored program computer concept (an abstract artifact) in 1945 created by John von Neumann and others, the principles of which would be incorporated not only in the first digital electronic stored program computers (material artifacts) implemented in 1949 but also in virtually every other physical computer since.

But there is another marker of originality in the historicist sense. An artifact is produced at some point of time *T* and it is discovered at some (possibly *much*) later time *T'* that an artifact was created bearing a marked similarity to the earlier artifact, though there may be no evidence of an epistemic connection between the two. This has been referred (by the present writer) as *A*-creativity ('A' for anticipatory) (Dasgupta, 2019, p. 30). Perhaps the most interesting example of this is Charles Babbage's design of the Analytical Engine in the mid-19th century which anticipated by almost a hundred years, the stored program computer concept.

So the historicist proposition leads to four kinds of creativity: Boden's well known *P*- and *H*- varieties, and the more recently identified *C*- and *A*- varieties.

The Judgement of Creativity

Consider now the second question raised in [section The Agenda of Computational Creativity](#): who decides an artificer to have been creative? It needs to be recognized that for every act of creation there will also be a *consumer* of the produced artifact: a fellow scientist, a fellow artist or a connoisseur, a literary critic, an informed user and so on. The consumer may be contemporaneous with the artificer or at a temporal distance — perhaps decades or even centuries later. The consumer may also serve as the *judge*. In certain domains, such as the sciences, the only kind of consumer who can serve as a reliable judge is one who possesses the knowledge, training, expertise and intuition to make responsible judgement. Such a judge may be called a *peer consumer*. Other domains, in addition to peer consumer-judges, may also have *lay consumers* who also judge — e.g., the 'ordinary' literary reader, the art or music lover, the film watcher, etc.

So here is the scenario that emerges. First, the unit of creativity is a triplet: <artificer/artifact/consumer>. Just as there is no creativity without the artifact or the artificer, there is no creativity without the consumer. Second, there is no objective criterion whereby creativity can be determined. It is, instead, a matter of subjective judgement, where the judge may be the artificer herself or more usually a consumer. The situation may be formulated in the following manner:

There is an artificer who brings into existence an artifact. This 'act of production' becomes an 'act of creation' when (and only when) the artifact is judged by one or more consumers to be significantly original in the *P*-, *H*-, *C*-, or *A*- sense. The artificer is accordingly judged to be *P*-, *H*-, *C*- or *A*-creative.

Here, note that a distinction is made between originality and creativity: the former refers to the artifact and the latter to the artificer. This scenario also implies that because of the subjectivity of its judgement, what might seem to be a case of creativity to one consumer-judge might not be so to another. Picasso's *Les Demoiselles d'Avignon* was rejected by some of the artist's closest friends when they witnessed it as work-in progress in 1907. In the eyes of these particular peer consumers — all possessing considerable expertise and sensibility in matters of art — the painting was judged novel but not valuable, thus not an expression of creativity. Ten years later, however, a different judge, pioneer of surrealism André Breton judged it very differently, and in 1937 Alfred Barr, then director of New York's Museum of Modern Art proclaimed the work as arguably the most important painting of the 20th century.

The Artificer as a Purposive Being

There is yet another essential aspect of human creativity that must be noted: an act of production begins in a *goal* or *need* generated in an artificer's mind. For example, a scientist feels the need to satisfy his curiosity about some newly observed natural phenomenon; a poet desires to respond to a felt emotion; an inventor, dissatisfied by the performance of a particular machine feels the need to improve its design; a novelist desires to capture her childhood by writing a story.

Thus, the creative artificer is a purposive being; creativity is a purposive phenomenon. Perhaps the supreme and most universal desire manifested by creative artificers is that they wish to deviate from the norm; to *be* original. One may think of this as

a ‘superneed’ without which no act of creation can even begin. But there are lesser though still compelling needs, such as the writer’s need to write, the painter’s need to paint, the scientist’s need to explain, the inventor’s need to invent, and so on.

The Artificer’s (and Consumer’s) Discourse Space

The artificer is not an island of her own. As noted she needs consumers, preferably a *society* of consumers. Consumers may serve as judges but they also serve as agents of transmission of the created artifact to other members of their society, or even to other societies. This is one of the means by which C-creativity obtains.

More generally, the human artificer plies her trade in what may be called her particular *discourse space*. The society of consumers constitute one component of this space; so does culture — the matrix of customs, traditions, manners and mores, symbol structures, knowledge and beliefs, values, perceptions, language, art objects, utilitarian objects, and world views, the *artifactual world* — she is embedded in, has inherited from outside her skin. Collectively, society and culture constitute the *environmental* part of the artificer’s discourse space.

There is also, of course, the *cognitive* part, which resides within the artificer, containing structures of beliefs and knowledge, affects (emotions), needs/goals (including supersedes) and a repertoire of mental operations.

The artificer, thus, posed by a particular situation — derived from her discourse space — experiences a need or desire which leads to her constructing a goal in response; drawing on elements of her discourse space she constructs a cognitive process (out of her repertoire of mental operations which may direct physical actions) that produces an artifact in response. Collectively, this process constitutes the artificer’s act of production.

Whether this artifact is original or not and whether in producing it the artificer manifests creativity, is judged by one or more consumers from the artificer’s environmental subspace; the latter in turn may appeal to *their* respective discourse spaces in order to make this judgement and to judge the nature of this creativity — whether it is of the P-, H-, C- or A- variety.

The Challenges for Computational Creativity

There is much more to this model of the human act of creation which for lack of (textual) space we must omit. For instance there is the thorny problem of the role of the unconscious in the act of production; the role played by mental schemas in creativity; and the fact that human creativity involves a sense of the past — a historical consciousness or sensibility — in the relevant domain of creation. (These and other relevant matters are discussed at some length in [Dasgupta, 2019](#).) But this model, as briefly stated, suffices to make sense of the challenges posed to computational creativity research.

If the goal of computational creativity is the theory and practice of how artificers *that are themselves computational artifacts* may manifest creative behavior as perceived by human beings (see [section The Agenda of Computational Creativity](#)) then it is human creativity and its production that sets the bar of acceptability: to what extent and how does such a computational act of creation manifest characteristics of the human act of creation? Herein lies the first challenge for computational creativity. [Colton and Wiggins \(2016\)](#) frame this challenge in terms of the extent to which computational systems may take on the “creative responsibilities” normally manifested by human artificers. In fact, as the literature indicates, it is the judgement of creativity — the act of consumption — that emerges as the lodestone for assessing progress in computational creativity research rather than the actual act of production itself ([Lamb et al., 2018](#)).

One of the most impressive early projects in computational creativity was the work by Pat Langley and his collaborators in the mid-1980s (summarized in [Dasgupta, 2019](#)). They took up the challenge of building computer programs that would ‘re-discover’ some of the classical quantitative and qualitative laws of physics and chemistry.

One of these programs, called BACON.1 ‘discovered’ several versions of Kepler’s third law of planetary motion. BACON.1 was a heuristic program which employed a repertoire of heuristic rules, some of which were used to gather data (by requesting them from the user), others that served to detect regularities in the gathered data, and still others that inferred ‘higher level’ patterns from these regularities including, ultimately, Kepler’s third law.

In fact, a scrutiny of BACON.1’s discourse space reveals that it is comprised solely of these heuristics. There are no items of astronomical knowledge or beliefs that BACON.1 draws on — the sort that Kepler *actually* drew upon as documented in the historical account of Kepler’s discovery of the third law *circa* 1619. The ‘discovery’ by BACON.1 was driven entirely by numerical data with no influence of the physical or astronomical aspects of the data, nor of any representation of the kind of physical intuition or meta-physics that drove Kepler in his quest for a quantitative law of planetary motion. It is difficult to believe that the contents of BACON.1’s discourse space had any resemblance to Kepler’s discourse space. There is also the crucial fact that the originating goal with which BACON.1 began its search for the law was not of its own making; it was *provided* as an input to the process.

So what can be said about BACON.1’s creativity? Clearly it was not H-creative with respect to the *human* history of science: BACON.1 did not in any way add to the body of knowledge about the physical universe. Nor, so far one can tell, was it consequential to the future history of either physics or astronomy; nor did it anticipate future discoveries — thus it was also neither C-creative nor A-creative. In the realm of understanding human creativity its one impact was to show that it is *possible* for an artificer to produce new rules or patterns by treating problems as exercises in formal symbol manipulation. In the context of the annals of *computational* creativity, on the other hand, a different picture obtains. It was certainly H-creative with respect to the history of computational

artifacts; and, insofar as it influenced future work in computational creativity, it was also C-creative. Therein lies its significance as indeed does the entire suite of programs Langley et al. built.

The complication that computational creativity poses (and human creativity does not), is that in the former, there are *two levels* of creativity: at the human level, the artificer is the computer scientist or programmer who builds a computational artifact (such as BACON.1) which performs certain kinds of tasks. Here, the human being is the artificer and the computer program is the artifact produced. At the computational level, the computer program or artifact is the artificer and the outcome of its particular task is yet another artifact (e.g., Kepler's third law or the proofs of logic theorems in the case of LT).

However, in *judging* creativity, there is no difference between the human and the computational levels: the only real option is the human consumer-as-judge. Judgement of BACON.1's creativity (or that of any of the other programs Langley et al. built) lies in the hands of human beings just as does judgement of Langley et al.'s creativity. So here lies the second major challenge for computational creativity: to design and build computational artifacts that can *themselves* serve as consumer-judges for the creativity of computational artifacts that are artificers.

There is yet a third challenge facing computational creativity research: Research into human creativity entails eliciting declarative knowledge ('know-that') about the nature of human artificers. Research into computational creativity also entails eliciting declarative knowledge about the nature of artifactual artificers; but there is the further step of inventing procedural knowledge ('know-how'): how to make such artifactual artificers.

Forging the Computational Creativity Discourse Space

Thinkers of many stripes have pondered the nature of human creativity for over two millennia. Thinking about computational creativity, in contrast, has a history that is barely seventy years old beginning with Alan Turing's celebrated 1950 essay "Computing Machinery and Intelligence". Thus, while the agenda of computational creativity has the undoubted advantage that it can build on what is known about human creativity, it has also branched off on its own to some extent, in part shaped by developments in AI but also in part stimulated by the specific conditions that underpin the *technological* aspects of the agenda. Computational creativity has thus forged a discourse space of its own.

Boden (2010) for instance has suggested that the act of production itself may involve three kinds of processes. The first entails making unfamiliar or unusual *combinations* of known ideas. This was actually proposed several decades ago by Arthur Koestler in the context of human creativity: he called it 'bisociation' (Dasgupta, 2019, pp 161–162). In the realm of computational creativity an example is the composer David Cope's (2005) system which selects particular elements of music from various compositions and links them together according to certain 'linking' rules of composition. In one situation Cope's program takes notes from different Bach chorales and linked them together to create its own original chorale which, in the words of Bruce Buchanan (2001) "Bach never wrote but might have" (p. 16).

Boden's second kind of process entails *exploring* a conceptual space. This, of course, is the now-classical idea of *heuristic search* — searching through a 'problem space' using heuristic rules to propagate and guide the search — pioneered by Newell and Simon (1972). A particularly notable system that combined both heuristic search and the combinatorial approach ('combinatorial search'), reaching back to the late 1960s and early 1970s was the DENDRAL system (Buchanan, 2001). Its domain was structural organic chemistry, and its task was to analyze mass spectrographic and other chemical data and infer plausible structures of unknown chemical compounds. DENDRAL was thus a computational artificer which produced as (abstract) artifacts, hypotheses about plausible chemical structures. Here, given a complete definition of the problem search space DENDRAL first generates all plausible combinations of elementary units (that is, combinations that satisfy specific chemical constraints, thus pruning away combinations that do not meet the constraints), then identifies all possible structural hypotheses that are compatible with the combinations previously generated. It then predicts consequences from each structural hypothesis, compares the predictions with the original spectrographic data, and finally chooses a hypothesis that best explains the data.

What was especially notable about DENDRAL concerned the judgement of the artifacts it produced. Its consumer-judges were professional chemists. In one 'experiment', an eminent mass spectroscopist asked graduate students and postdoctoral fellows attending his seminar on mass spectrometry to interpret three mass spectra from the empirical formulas of the compounds and these interpretations were compared with those of DENDRAL by mass spectroscopists. Their conclusions were that DENDRAL's performance was comparable to those of the graduate students and postdoctoral fellows.

Boden's third kind of creative process entailed *transforming* the rules or concepts governing heuristic or combinatorial search. For example, in contrast to DENDRAL's fixed set of heuristic rules, META-DENDRAL actually 'discovers' new rules. Here, given a set of data concerning known chemical structures META-DENDRAL infers rules that explain the data collection. Remarkably, some of the rules discovered by META-DENDRAL were sufficiently significant, chemically speaking, to appear in the chemical literature.

Clearly, the transformational process, operating as it does at the 'meta' level, is the kind valued most in the realm of human creativity (Buchanan, 2001). For instance, Thomas Kuhn's celebrated concept of paradigm shift, in the realm of scientific discovery, would constitute the highest form of transformational creativity (Dasgupta, 2019, pp 74–77, 79). And, indeed, this is how Geraint Wiggins (2006) who, offering a formal model of the computational creativity discourse space, interprets transformational creativity: he sees the transformational process as a meta-level search process. In contrast Buchanan (2001) cites the artist Harold Cohen's well-known AARON painting program which, despite its manifest creativity, will never choose to break the rules designed into it by Cohen.

When people generally ask what goes on in creativity, it is the process whereby an artifact is actually produced — the act of production — they really have in mind. Small wonder, then, that much of creativity research — in the realm of both human and computational creativity — has focussed on this core process.

For instance, most researchers seem to agree, whether dealing with human or computational creativity, that the act of production is *evolutionary* in nature. By this is meant that it is a gradualistic process. This is obviously the case for Boden's exploratory and combinatorial kinds of processing, but it is also evident in the transformational case. For, while a transformation (from one concept or rule to another, one paradigm to another) may *appear* abrupt or quantum change-like, closer examination reveals that at a finer level of detail, evolution or gradualism is at work. Picasso's mural *Guernica* (1937), an H-original artifact, would surely qualify as an instance of transformational creativity. However investigations into its act of production (Dasgupta, 2019, pp 153–161) reveal a distinctly evolutionary pathway.

This evolutionary notion is not a recent idea. In the language of AI, it is described most generally as the 'generate-and-test' heuristic promulgated most influentially by Newell and Simon (1972), although more recent computational creativity researchers seem to have re-invented the idea and given it their own names such as 'generate and explore' (Genenplore) (Finke et al., 1992) and 'engagement-reflection' (ER) (García et al. 2006). In the realm of science, there is a well known evolutionary model of the growth of scientific knowledge that closely adheres to the generate-and-test heuristic: given a problem to be solved the scientist proposes a tentative theory which is then tested against observations; if an error is found, the theory is modified to produce an improved tentative theory and so the process continues until a theory emerges that satisfactorily solves the original problem. Art historian E.H. Gombrich proposed a similar process in the realm of painting (which he dubbed 'making-and-matching') wherein the artist beginning with an initial schema (derived from past art) modifies it, matches the result against his expectations, finds a difference, modifies the artwork to narrow the difference, and so on (Dasgupta, 2019, p. 66).

The real disagreement between creativity researchers lies in the *nature* of this evolutionary process. One view, first advocated by Donald Campbell in 1960 and most vigorously promulgated by Dean Keith Simonton postulates a Darwinian type of evolution: in very general terms, given a goal, the creative process entails the blind generation of a compendium of artifacts in response, and the retention of that artifact that satisfies the goal. This model has come to be called the 'blind-variation, selective-retention' (BVSR) theory of the creative process. A wholly contrary view rejects BVSR theory as a *universal* model, especially the component of blind variation generation. This view argues that actual historical case studies of H-original and C-original artifacts reveal evolutionary pathways wherein gradual progress is made towards a satisfactory target artifact based on input from the artificer's world space, current goals, and the current state of the artifact-in-progress. The process is, rather, a case of *purposive evolution* since it is goal-directed (Dasgupta, 2019, pp 142–152).

It should be noted that the classical search strategies used in heuristics-based AI systems, — such as generate-and-test — are instances of purposive evolution. The Darwinian or BVSR strategy has been adopted under the rubric of *genetic algorithms* a computational strategy pioneered by John Holland in the mid-1970s.

As remarked, the process component of creativity has dominated the focus of both human and computational creativity researchers. But this by no means is to suggest that other aspects have been wholly ignored. Anna Jordanous (2016), for instance, has suggested that computational creativity should be investigated from the perspectives of the 'four P's': Person, Product, Process and Press. In the realm of human creativity this also is not a novel concept: In the language of this article, they refer to the artificer, artifact, act of production, and consumer-judge respectively. Jordanous makes the point that significant progress in computational creativity may obtain if all four P's are taken into account.

In the realm of the 'Person' (meaning the computational artifact-as-artificer) for instance, this may entail modeling personal human traits such as curiosity (Grace et al. 2017) or what Colton (2008) labeled the 'Creative Tripod' — skill, imagination and appreciation — as traits of the computational artificer. To these one might add superneeds (see section **The Judgement of Creativity**), such as the need to deviate from the norm, or other lesser but still compelling needs: the need to write, to paint, and so on.

In the case of 'Product' (the artifacts produced), the efficacy of computational creativity systems has been judged on the basis of the originality of the artifacts. This is hardly surprising given that the four types of creativity attributable to artificers discussed earlier (P-, H-, C- and A-) are defined in terms of the P-, H-, C-, and A-originality of the artifacts.

As for 'Press' (meaning the societal-cultural part of the artificer's discourse space) its significance lies in that just as consumers plays an essential role in judging human creativity, so also 'Press' will play a role in the judgement of computational creativity. At the very least this means that the design of a computational artificer should take into account the kind of consumers that will judge the system's creativity, 'Press' also has a role to play in considering 'Person': Colton (2008) has argued that a computational artificer need not necessarily possess such traits as curiosity, skill or imagination but should *appear* to possess such traits. Only then will the human consumer acquire at least the perception that the computational artificer is creative.

Most recently, using the 'four P's' as a framework, Lamb et al. (2018) have proposed a menu of heuristic rules ('takeaways' as they call them) as possible elements of the computational creativity discourse space which the designer of creative systems should take into account.

'Creativity but Not as We Know It'

Ultimately computational systems will be judged for their creativity according to the criteria set by human creativity studies. Anthropocentrism can hardly be avoided. But there is also the hope — and impetus — that computational artificers might be invented in

ways that are ‘non-human’ in some sense: that computational artifacts will exhibit creativity “but not as we know it” (Colton and Wiggins, 2016). Such artifacts will then manifest a variety of creativity that may be beyond normal human capacity – a situation wherein computational creativity may actually prove to be *superior* to human creativity.

How can this happen? One way is to extend combinatorial search into domains involving very large volumes of data — situations which humans are not very good at handling. The new science of ‘big data’ (data analytics) may be especially useful in such domains. For instance Varshney et al. (2013) describe a big data approach to the production of food recipes wherein not only is the volume of data large but is varied: large sets of existing recipes, data about food at the molecular-chemical level, and data about flavors. Their system deploys algorithms that generate thousands, even millions of new ideas from a ‘recipe space’, evaluates them according to criteria founded on both principles of neurogastronomy and psychophysics and selects the best ones. Thus, the act of consumption-judgement is itself integrated into the system as a component (called the ‘work product assessor’). Such judgment gives premium to both novelty and quality of the artifacts (recipes) produced. However, the resulting recipes have also been judged by professional chefs. The system is designed according to a model of the human creative process that is remarkably comprehensive in that it incorporates almost the full gamut of the ingredients researchers have come to identify in the realm of human creativity.

Computational Thinking, Redux

It seems appropriate to end this discussion where we began: in the realm of computational thinking. For, if “creativity, but not as we know it” is one way whereby computational creativity can go beyond the extent of human creativity, another is to draw on computational thinking to shed light on human creativity. The one represents a *concrete* (technological) embodiment of computational creativity; the other is a conceptual tool – an *abstraction* – to help understand human creativity.

In particular, the concept of the mind as a computational machine affords a powerful *metaphor* for understanding aspects of the human creative process. As an example, consider Gruber’s (1989) proposition that the creative artificer is usually engaged in a ‘network of powerful enterprises’ — that is, a collection of ‘related projects’ all of which contribute to the larger purpose at hand. The computational metaphor provides a basis by which one can more precisely characterize this idea by appealing to such computational processes as ‘parallel processing’, ‘time-sharing’, ‘interprocess communication’ and ‘multiprogramming’. Thus, Herbert Simon’s multidisciplinary creativity as an instance of Gruber’s network of enterprises can be explicated as a network of interacting, communications, time-shared cognitive processes, while the process by which Picasso arrived at his mural *Guernica* can be characterized in terms of the idea of multiprogramming (Dasgupta, 2019, pp 159, 184–192).

The computational metaphor, of course, serves as a *scaffolding*: once the metaphor has served its purpose it must be discarded. The verification or refutation of explanations is an empirical task that lies outside the metaphor itself.

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Technology: Computerized Text Analysis

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Glossary

Close reading In literary studies, the careful interpretation or analysis of a text or passage of text, with focus on phenomena such as multiple meaning, paradox, or irony.

Digital humanities (DH) An academic application of computational tools and methods to traditional humanities disciplines such as literature, history, and philosophy.

Distant reading Data interpretive approach to literary collections, to seek and assess patterns in the history and evolution of literature and literary forms.

Formalism The study of art by analyzing or comparing form and style. Literary formalism is a type of criticism and theory, which concentrates on the forms and structures within texts as opposed to cultural contexts or external interpretations of texts. Well-known is Russian formalism, giving importance to the specificity and autonomy of the forms in literary language.

Psychometrics/psychometric Relating to the theories and techniques of psychological measurement.

Stylometry/stylometric The application of linguistic style to analyze written material. Often used to attribute authorship to disputed or anonymous documents.

Text mining The process of deriving information from text, also referred to as text analytics. The information typically emerges through the application of natural language processing and statistical pattern learning.

Introduction

Computer-assisted data analysis has become standard in many sciences, from traditional forms like physics and chemistry to new fields like bioinformatics (computational understanding of biological data). In the social sciences, computational data analysis is used to explore topics such as voting patterns, media coverage, and economic trends. In the humanities, where narrative data are paramount, computerized text analysis evolved to understand functional aspects of history, anthropology, philosophy, art, and

Table 1 General characteristics of traditional and computational approaches

<i>Traditional</i>	<i>Computational</i>
Qualitative	Quantitative
Close reading	Distant reading
Content	Arrangement
Semiotic (symbols)	Formalist (structures)
Meaning interpretation	Pattern recognition
What readers infer	How texts behave/function
What writers intended	How writers constructed

literary objects such as plays, short stories, and novels. Although CTA can be applied to any textual environment, this entry will address its employment in the evaluation of creative writing.

Though finer distinctions can be made between the terms *computerized* and *computational*, they are used in this entry synonymously. CTA includes an assortment of quantitative strategies such as text mining, analytics, and visualization. These strategies are central to disciplines such as computational linguistics and natural language processing, both of which are routinely applied to endeavors ranging from government intelligence gathering to consumer shopping habits. Topics in the humanities have also come under the scope of quantitative assessment, with computer-assisted approaches sometimes referred to as digital humanities (DH).

Neither CTA nor DH intend to replace traditional research methods but instead augment them. Computational researchers tend to be versed in the same historical and linguistic topics as other researchers, yet the power of the computer has opened additional avenues and led to new questions. A few key distinctions and terms between traditional and computational approaches to creative writing are shown in [Table 1](#).

Author Attribution

Identifying the author of a text and inferring characteristics about that author is a practice common in forensic linguistics, or the application of linguistic knowledge and methods to the context of legal disputes and criminal investigations. A particularly successful method for creative writing is *stylometry*, or the study of linguistic style. Stylometry started prior to the computer revolution but with mixed results. Humans write and read for content, organizing words into phrases and sentences to produce meaning. However, stylometry's success relies on detecting the frequency and placement of functional words like prepositions and pronouns, which carry an author's stylistic signature. As [Pennebaker \(2011\)](#) discussed in *The Secret Life of Pronouns*, analysis of functional language also reveals psychological characteristics (another type of style) about the text. In the case of a fictional work like a novel, functional language reveals psychological tone in the story, narrator, and what literary studies sometimes refer to as the implied author. Whether stylometric or psychological in scope, such detection often requires a level of quantitative data analysis too intensive for human readers working with paper and pencil. Not surprisingly, stylometry and author attribution studies advanced exponentially with the aid of CTA. The following two examples, of *The Federalist Papers* and the works of William Shakespeare, are well-known historical cases.

The Federalist Papers

Alexander Hamilton or James Madison, or both? In the history of attributing authorship, one of the most famous cases concerns *The Federalist Papers* (1787), a set of 85 essays and articles that influenced the ratification of the US Constitution. As known at the time, the authors of the entire collection were Alexander Hamilton, James Madison, and John Jay. However, 12 of the essays made particularly challenging arguments that no one man wanted to take responsibility for writing until years later, when Hamilton and Madison each claimed sole authorship. The issue went unresolved, as Jay died in 1802, and Hamilton was killed in a pistol duel with Aaron Burr in 1804, leaving Madison with no one to corroborate his own claim to authorship. Hamilton and Madison were of similar age and education, who had collaborated on several of the other essays in the collection, so determining who had written the 12 disputed pieces proved impossible through content analysis alone. The mystery continued to perplex American historians for nearly two centuries.

A breakthrough came in 1964, when statisticians Mosteller and Wallace applied Bayesian inference to functional word frequencies. Their conclusion was that Madison wrote the disputed essays. Although some historians remained skeptical, subsequent studies using CTA, in 1998 and again in 2003, supported the conclusion that Madison was the sole or at least primary author. In 2004, a CTA of representational language running throughout *The Federalist Papers* made a stronger case for Hamilton's contributions to Madison's writing.

Did Shakespeare Write Shakespeare?

No literary debate is more famous and polarizing than whether the plays of William Shakespeare were written by William Shakespeare, with conspiracy theorists alleging that the name Shakespeare itself was perhaps a pen name for an anonymous author. The

controversy began in Victorian Britain and led to a feud in academia over textual discrepancies in the Shakespearian canon, a controversy clouded by the factual and mythical narratives regarding the real life of Shakespeare. Researchers began using traditional text analysis early in the 20th century to help deal with the discrepancies, which addressed a few questions but left many unanswered.

In research published in *The New Oxford Shakespeare: Authorship Companion* (Taylor and Egan, 2017), the latest in stylometry and CTA was employed on the 44 plays of Shakespeare (the known canon of 37 plays plus seven suspect or misattributed titles). For decades, the Oxfordian view challenged the traditional, Stratfordian perspective that Shakespeare was the lone and original author of all works bearing his name. This time, the research confirmed arguments from both camps. On the one hand, Shakespeare appears to have written all 44 plays to his credit. On the other hand, as many as 17 of those were collaborations with other writers, including long-time suspect Christopher Marlowe. In independent research that supported the conclusions, Boyd and Pennebaker (2015) mapped the psychological signature in *Double Falsehood*, a play believed to have been written by Shakespeare but commonly attributed to an 18th century author. The CTA of all potential writers clearly indicated that this title was Shakespeare's but also a collaboration with known colleague John Fletcher.

Features of CTA

Levels of Inquiry

Advantages of CTA include the levels at which such analyses can focus. Whereas traditional close reading and analysis tend to operate at one level of data, where the human reader is what Franco Moretti (2017) called "an anthropocentric scale" (p. 65), CTA can approach the data at multiple levels.

Microanalysis

CTA can identify patterns and features within texts that escape human readers. Microanalysis is the closest extension to the traditional method of close reading. However, written narrative has evolved throughout the centuries, and spoken forms of narrative are prehistoric, leaving human readers culturally and psychologically conditioned to read texts in particular ways. Computers can evaluate operationalized variables and be programmed to find patterns on their own, to show, for instance, how particular novels or novelists use certain types of language or topics and how those types unfold over the duration of a narrative. An example is the novel *Moby Dick* (1851), in which Jockers (2014) quantitatively illustrated how references to Captain Ahab negatively associated with references to the Whale. The pattern showed how author Herman Melville used his narrator, Ishmael, to frame Ahab and the Whale separately, setting them up as two titans headed toward classic confrontation.

Macroanalysis

CTA can read text collections too large for human readers. Macroanalysis evolved as computing power expanded and print objects such as novels increasingly became digitized. Compared to the traditional method of choosing certain texts and drawing conclusions about literary canons, genres, or histories, computers can process hundreds of variables and thousands of volumes in a targeted genre, corpus, or archive. Working at this level is productive when tracking macro evolutionary changes in literature. Fig. 1 shows a word-frequency macroanalysis of gender references in a corpus of American fiction writing over 16 decades (1850s–2000s). The vertical axis illustrates the ratio between the frequency of words operationalized as *female* (e.g., she, her, sister) and *male* (e.g., he, him, brother). The comparatively low frequency in the appearance of female references (i.e., female characters and agency) occurred through the decades of the 1910s through 1980s, with a female peak in the 1870s and again in the 1990s through 2000s (see Novels on history regarding gender).

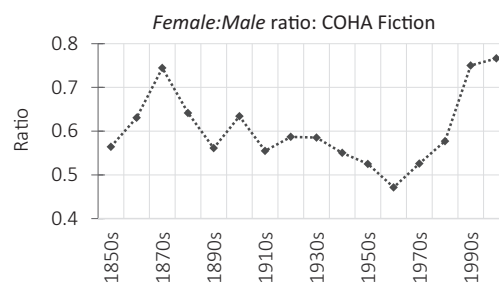


Figure 1 Word-frequency ratio of *female:male* references (variables) in American fiction, decades of 1850s through 2000s. Each variable operationalized in the 2015 edition of *Linguistic Inquiry and Word Count* (LIWC2015), the software used in the study. The data are from the Corpus of Historical American English (COHA) (<https://www.english-corpora.org/coha>). From Fairchild, T. E. (2019). *Emotion, Embodiment, and the Novel: Word-Frequency Characteristics and Dystopian Masterworks*.

Mesoanalysis

CTA can help identify and track links between micro and macro levels of data. In response to the stricter parameters of micro and macro analyses, mesoanalysis has become the preferred approach in DH and CTA research focused on meaning and connection in creative writing. The mesoscale was an idea adapted from meteorology, a level of data interpretation that links local weather events to larger scale atmospheric activity. In a digital literary study, a mesoanalysis might connect patterns running through individual texts or authors to broader patterns in corpora or language. In a doctoral dissertation in classical studies, [Marley \(2018\)](#) analyzed the writings of eminent Roman orator Marcus Cicero (106–43 BCE). Although Cicero is a well-studied historical figure, Marley's CTA revealed new insights about his writing and life. Marley processed Cicero's letters through the open-source software tools RStudio and Gephi to build a visual network of his peers and interactions. The researcher also employed sentiment analysis (natural language processing of subjective information) to track the affect trajectories of Cicero's speeches and contextualize them against Latin rhetorical theory and modern social-psychological theories on ancient emotions.

Techniques

Three key concepts in computational criticism are frequency, shape, and space, which build off one another.

Word Frequency

Word counting contends with frequency in data and is an early and comparatively straightforward strategy, a process that originally used manual counts (with paper and pencil) to build operationalized word sets for statistical analyses. The labor-intensive slowness of this method meant a limited number of variables and a limited number of texts, a problem overcome since by the expansion of computing power. Word-frequency analysis remains the easiest method to understand and implement, and is supported by a variety of software applications, ranging from free-download tools to professional packages (refer to [Fig. 1](#), for visual example of word-frequency research).

Topic Modeling

Model building addresses shape and space in data and has a long and successful track record in the sciences. The specific technique of topic modeling originated in computer-assisted linguistics, where software categorizes the words of a document into mathematically correlated clusters called *topics*. Like word-frequency method, an advantage of topic modeling is that it can be applied at any level of inquiry, from the individual poem, article, or book to literary corpora or newspaper and journal archives. Unlike word-frequency method, topic modeling is a type of text mining, the most advanced of which takes advantage of machine learning: algorithmic use of patterns and inferences to learn directly from target data rather than following explicit human instructions. Specific and useful mining processes include text clustering, concept extraction, and association analysis, as well as the network nodes, sentiment analysis, and visualization techniques used in [Marley's \(2018\)](#) study of Cicero. Text modeling has developed into a favorite approach for many researchers in the digital humanities, including the [Archer and Jockers \(2016\)](#) research on bestselling novels discussed later.

Narrative Space

Spatial tracking and awareness originated in the ancient field of geography, for constructing maps and navigating locations. In narrative studies, spatial tracking applies to the representation of physical places in texts but also to the topical and thematic allocations of narrative space, a space that is itself organized around time. Examples include two experimental historiographies by CTA pioneer Franco [Moretti \(2005\)](#), who mapped the 19th century European novel onto physical histories of Europe, and then used maps, charts, and timelines to visualize a larger system of world literatures. Another example involves a Euclidean distance metric (a vector measurement between two data points), combined with a phylogenetic tree (a visual used in evolutionary biology), which together map spatial distances between individual sets of texts. [Fig. 2](#) illustrates this example, of five language types from the Corpus of Contemporary American English (COCA) processed through 10 psycholinguistic variables (see [Table 2](#)). The research result indicated that fiction writing was the most distinct among the types.

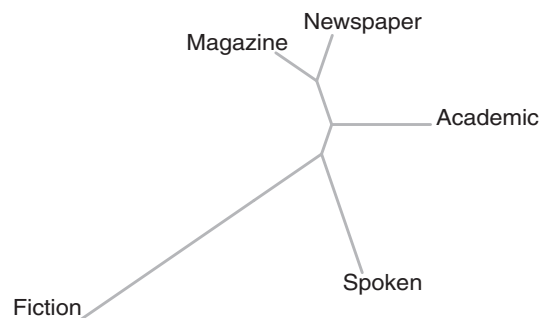


Figure 2 Euclidean distances for 10 psycholinguistic processes. The unrooted tree shows fiction as the most distinct of five types.

Table 2 Euclidean distances for five language types

COCA: Euclidean distance (d)				
	Magazine	Newspaper	Academic	Fiction
Spoken	3.48	3.97	4.08	6.26
Magazine	-	1.56	2.72	4.89
Newspaper		-	3.09	5.23
Academic			-	6.66

Euclidean distances for 10 psycholinguistic processes (from LIWC2015) applied to COCA (<https://www.english-corpora.org/coca>). The numbers are relative scores of how distinct the language types (fiction writing, magazines, newspapers, academic, and spoken language) were from one another (the larger the number, the more distinct). From Fairchild, T. E. (2019). *Emotion, Embodiment, and the Novel: Word-Frequency Characteristics and Dystopian Masterworks*.

Software

Numerous software options exist for doing CTA. These range from general computational and statistical programs to specific frequency, modeling, and visualization applications, both free and licensed. The type of CTA lends to the platforms and packages used, with individual fields and academic programs each having their respective histories and preferences. The following is a short list of desktop software with track records in research on creative writing:

- *RStudio*. An open-source (free) software interface for the R statistical computing environment. R is a vector language requiring computer programming skills, which RStudio turns into a GUI (graphical user interface) with drop-down menus more easily accessible to the less technical user. Much of the power of R resides in the hundreds of free support packages developed by global R developers: collections of functions and compiled code designed for tasks such as analyzing evolutionary patterns and drawing graphical illustrations. R computing has become a popular platform in literary studies, programmable at the micro, macro, and meso levels.
- *Linguistic Inquiry and Word Count*. A word-counting engine but with a psychometrically validated word dictionary that makes the software into a tool for psychologically evaluating individual texts and entire corpora. LIWC (pronounced “Luke”) is a commercial program in its fourth edition as of year 2015. It has been used in published research on a variety of writing types: (i) student essays; (ii) the expressive journals of clients undergoing therapy; (iii) poetry and prose fiction (see [Boyd and Pennebaker, 2015](#), on Shakespeare study); (iv) newspapers and other periodicals; (v) webpages; (vi) blogs and Twitter accounts; and (vii) affective responses in the aftermath of the 2001 September 11 attacks, research which led to the formation of a new emotional tone category in the LIWC2015 edition.
- Other software available for standard computers include: *Gephi*—open-source network analysis and visualization; and *Rapid-Miner Studio*—commercial package for overall data mining and analytics, applicable to text.

Procedures

Whether on fiction or nonfiction, conducting CTA typically begins how any scientific study begins, by formulating a research question. The researcher must also determine the data source, usually an available corpus or a set built specifically for the research. If the latter, the researcher must find, acquire, and prepare the data just as any analyst would. If conducting CTA on the canon of Shakespeare, for instance, the researcher would need electronic (digital) copies of the works in the canon, which are currently in the public domain. If conducting CTA on someone like a living novelist, who is not in the public domain, the researcher would need to acquire digital versions of the novels legally. In the case of tracking writing such as individual blogs, or the evolution of language in the World Bank’s Annual Reports since 1945 (see [Moretti, 2017](#)), or the tone of the entire *New York Times* archive, each would require a particular approach to data acquisition. Once the textual materials have been acquired, they must be cleaned of extraneous information such as editor’s notes, leaving only the targeted content for analysis. These acquisition and preparation steps can be performed individually by the researcher, but with large datasets a software platform like R can be programmed to assist or conduct them automatically (see [Jockers, 2014](#)).

Digital texts, archives, and corpora exist in a variety of sources. Two that are readily available on the Internet and have been used in peer-reviewed research include:

- *English Corpora* (www.English-corpora.org). The site offers publicly accessible English corpora, with individual corpora organized around writing types such as American contemporary, American historical, early British, web-based, and Internet news.
- *Project Gutenberg* (www.Gutenberg.org). This archive offers nearly 60,000 free eBooks, which include every major literary work in the public domain. The archive is a popular mining source for historical literary research appearing in peer-reviewed studies. Because the texts are in the public domain, and domain laws vary by country, the archive includes only a small collection of titles published in the 20th century, which limits research to mostly the 19th century and earlier.

In Practice

Writing a Novel

Perhaps the single biggest concern in moving the humanities into computational, data-driven, quantitative territory is based in the fear of defacing or corrupting accepted beliefs about writing and writers, both individually and collectively. In a quantitative data approach on novels and how to write them, Blatt (2017) examined more than 1500 texts, which included classic and contemporary bestselling novels, bestselling writers' guides for aspiring novelists, and amateur and self-published works of fiction. From the evidence, Blatt came to two important conclusions:

1. advice on how to write a successful novel is inconsistent among experts; and
2. amateurs like fan-fiction writers have yet to graduate to successful novelists.

Blatt's first conclusion represents a criticism of the lucrative how-to book market on writing fiction and becoming successful. Though the essential aspects of storytelling and narrative form are rooted in human psychology and have changed little over the centuries, specific language and its implementation face continuous evolutionary pressures, from markets, readers, critics, writers, and culture at large. The upside of Blatt's conclusion was that, given the inconsistencies regarding the path of a writer's success, aspiring novelists can take comfort in knowing that a one-size-fits-all recipe does not exist.

Blatt's second conclusion represents a cold reality for the same aspiring novelists. While computers have made it easier for individuals to sit at a keyboard and produce language, sometimes churning out millions of words of fiction per year, Blatt's research showed that the practice alone simply does not lead to publishable authors. Despite the lack of consistency in what constitutes good novel writing, a consensus does exist on what constitutes poor writing, which corresponds strongly to not being published. From a creativity perspective, fiction writing is a domain-specific craft, requiring a great deal of time and practice to master. To become a successful novelist, a writer must develop a discipline for crafting and editing, and for shopping a manuscript that can be sold as a product.

The Blockbuster Novel

Catchy titles that imply definitive answers on the production of art tend to be treated skeptically by experienced artists and critics alike. In *The Bestseller Code* (2016), however, the researchers were veteran literary agent Jodie Archer and literary text-mining pioneer Matthew Jockers, each associated with major computational text labs that support studies in language, history, and anthropology. Their primary research question asked: What do novels from the *New York Times* bestseller list have in common at the level of textual characteristics? The task appeared daunting since almost any genre, theme, and style of writing has historically become a bestseller at some point, from Pulitzer Prize winners, to romance novels, to the likes of *The Girl with the Dragon Tattoo* (2005), a tale published posthumously by a Swedish political writer that contains explicit scenes of sexual violence.

The fiction retail industry is organized around the assumption that the most important aspect for the reader of a novel is what the novel is about. Accordingly, the issue of bestselling title has invariably been left to publishers and market researchers, most of whom treat such works as luck of the draw. The result is that the current trend in fiction publishing is for companies to allocate most of their budgets to an underdiversified portfolio of high-profile veteran authors, which ensures some intermediate profitability but represents a poor investment strategy in the long term, to the industry economically and to the culture in general. In analyzing nearly 5000 novels through a text mining strategy, Archer and Jockers hoped to construct a method by which to identify potential bestsellers among new and unknown authors, which could be used to help develop writers, writer programs, and ultimately a better-functioning fiction industry. Although one writer might produce thrillers and another romances, if both are highly successful, then both must be doing something in the same way.

Using traditional text analysis to examine what this same way might be would have required years of close reading my multiple readers, but a pair of individuals working computationally needed only a few months. Most of that time was spent programming the algorithms necessary to clean, convert, read, and analyze the text data. The computer must be trained to read every word within the context of surrounding words, which Archer and Jockers (2016) did by topic modeling through R programming. Although the researchers did not, nor intend to, provide definitive conclusions about the construction of bestselling novels, their machine algorithms correctly identified nearly 85% of the bestsellers from a set containing thousands of titles. When compared to non-bestselling novels, some recurring and telling patterns that emerged regardless of genre, style, or author popularity included:

1. *Common and grounded topics*: despite the prevalence of titillation and the fantastic in popular culture, these patterns appear far less frequently in bestsellers than in non-bestsellers. For instance, Danielle Steel romance novels are among the bestselling titles in history, in which the three most common topics do not include passion or explicit romance, but are *home*, *family*, and *medical*, with the specific topics of *sex* and *drugs* making almost no appearance.
2. *Focused topics*: bestsellers offer fewer topics, ideas, and subplots, and generally 30% of the narrative space focuses on the central topic or idea. For instance, John Grisham is known for legal thrillers, and approximately one-third of a given Grisham novel focuses on the model topic of *legal*, meaning the scenes or conversations entail some aspect of the law or legal system.

3. *Human closeness and connection*: intimacy over sex; a meal with a friend rather than a night on the town; locations that are familiar rather than exotic; dilemmas that are emotional or ethical rather than political or ideological. In short, for readers of popular fiction, bestselling novels address the ordinary aspects of real lives in familiar settings.

So how does any of that account for the blockbuster success (over 40 million copies worldwide) of a title like *The Girl with the Dragon Tattoo* (GDT), one rife with deception, corruption, revenge, and depictions of sexual violence: a dark if not unnerving novel that was dismissed by most American publishers and critics as offensive to literary values and American sensibilities?

The same machine learning algorithms that correctly identified over four-fifths of the bestsellers from a sample collection also gave GDT a bestseller probability score of 93%, based mostly on the category of female agency. The novel's female protagonist, Lisbeth, is a moody, self-focused computer hacker declared psychologically unstable by the state and motivated by retaliation: a young tattooed woman that exudes the opposite of traditional feminine qualities typically seen in bestsellers and most other narratives featuring female leads. However, the Archer and Jockers machine program also recognized Lisbeth as intelligent, resourceful, confident when necessary, and an underdog who is ethically superior in terms of her conviction to exposing violence against women: all the components that make for a powerful antiheroine. Despite the explicit scenes and Sweden-specific political intrigues, GDT also scored high in the essential bestseller territory of human closeness and connection. For all her external appearances and behaviors, Lisbeth is alone, longing for true companionship, falling in love with the novel's principal protagonist, an older man who can never reciprocate her feelings.

Evolving Language of the Novel

The final examples of CTA application are some of the most academic, most experimental, and most creative. Published by the Stanford Literary Lab under the title *Canon/Archive: Studies in Quantitative Formalism* (Moretti, 2017), much of the research addressed the evolution of novelistic language, research that tests institutional and popular boundaries regarding the interpretation of fiction writing.

In one of the studies, the approach borrowed musical principals such as crescendo to explore the narrative sense of loudness in 19th and 20th century novels. Musical compositions are played in notes and arrangements but also at changing volumes, both auditorily and perceptively. In a microanalysis of dialogic loudness, the research considered Part I of Dostoevsky's *The Idiot* (1869), which provided a working model for the relationship between word choices, characterization, and how loud the text (narrator) feels to the reader. The researcher operationalized exclamatory, punctuated, and critical language (e.g., *My God!*; *Don't blather*; and *What?*) as dialogically loud. As the data indicated, loudness applied in varying degrees to each character except one: Prince Myshkin, the protagonist. Dostoevsky wrote Myshkin as an embodied representation of honesty and integrity, which earns the troubled prince the reputation of idiot. As the language data showed, Dostoevsky used neutral expressive language only when writing Myshkin's character and dialog, segregating the prince from the chorus surrounding him, a chorus that collectively represents deceit, corruption, and moral emptiness.

Another study from the Stanford series examined the paragraph in the novel, a comparatively under-investigated construction. One conclusion was that different scales of study bring forth different features. Previous research showed how word tokens (i.e., research at the level of the word) are effective at distinguishing literary genres and one author from another. Likewise, sentences have proved useful in distinguishing writing styles. The paragraph, by comparison, is a construction that helps carry forth novelistic theme and motif.

In a third study from the Stanford collection, the research switched to the geospatial mapping of fictional London in 18th and 19th century British novels. Despite the radical growth and changes to the real city during the 19th century, the fictional city changed little, with authors revisiting well-known locations again and again, particularly the West End. The research also attempted to map emotional identifications in these novels with specific London locations. In agreement with additional research on loudness, the main conclusion was that British novels, including those set in London, underwent a quieting of exterior emotional expression, which matches qualitative research on the evolution of British fiction.

Implications

An implications section is included because new innovations almost invariably challenge established convictions. To date, CTA researchers working on creative writing must not only continue developing CTA methods but do so in a climate that often misunderstands or misrepresents their efforts (see Blatt, 2017, and Moretti, 2017, on the polarized nature of reactions to CTA in literary studies). Technology is a human-driven enterprise that changes humanity's relationship with knowledge, with creativity, and with itself. An example with far-reaching implications concerns the mechanical moveable-type printing press, which revolutionized the book and paved the way for mass literacy yet also caused radical change to the existing institutions and ideologies of the day. For Christianity and Western culture in general, the mechanical press produced the Gutenberg Bible, which inspired a print revolution that helped shift the power over belief from the church and educated scribes to anyone who could read. One major result was the European (Protestant) Reformation, which began with printed pamphlets and led to a religion more focused on scripture, the New Testament (NT), which in turn required a more literate population—the spread of the Koran played a similar role in the Arabic world.

Skipping to the present, computers are the latest phase in the evolution of print technology, where the long-term implications are equally as radical. Biblical scholars already arrived at a consensus that characters like Moses are fictional only, not historical. Through a combination of research in history, anthropology, and textual linguistics, scholars additionally concluded that the Christian NT contains numerous inconsistencies, revisions, and even forgeries regarding the story of Jesus. The conclusion was that the NT should be treated as a work of literature, not a historical document, thus separating the Jesus of the Bible from whomever the historical Jesus might have been. Rather than resolving a dilemma, this separation invited more questions. Applying Bayesian conditional probability to indepth textual analysis and the known historical record of the ancient Near East and Roman Empire, [Carrier \(2012\)](#) concluded that a historical Jesus, like Moses, never existed, leaving only the mythical character to consider.

Although computerized text analysis in most creativity-related research is less consequential than rethinking the core of a religion, the way that language, particularly written language, is researched and evaluated has already begun an evolutionary shift. The long-term implications can only be glimpsed, but centuries of advances in human science and understanding are becoming more necessarily interwoven with advances in computing power. This relationship should not be considered as the past being replaced by the future, but as forces evolving together to create an expanded paradigm. The book itself, for instance, is a technological achievement, but hand-copying volume after volume was ultimately inefficient, leading to machinery that advanced printed material to the forefront of modern civilization. Likewise, intuitive paper-and-pencil observation and analysis is the foundation on which modern scientific research methods are built, but delving deeper into mysteries such as the genome, or tracking exactly how many feminine pronouns occurred in the evolution of 19th and 20th century novels, requires machinery that can accurately process quantified datasets. Though genome research has the potential to resolve the much greater problem of cancer, understanding the trend of feminine pronouns is important for constructing an accurate history of female authors and characters, and thus challenging portrayals of women based on cultural ideology and rhetoric. At smaller scale, understanding the linguistic mechanisms employed by someone like Dostoevsky informs fiction writers and critics of the metaphorical brushstrokes by which such artists paint.

Feedback for Creative Writing

Approaches utilizing computerized text analysis offer new and interesting ways of assessing and ultimately understanding all manner of writing including creative writing. These approaches also present new methodological, empirical, and institutional challenges. As an outcropping of linguistic formalism, CTA is part of a movement to assess language by its moving components, arrangements, and designs. The formalist position began in response to the long history of hermeneutic assessment, a practice focused on content and meaning, which still informs linguistics and verbal art studies. However, formalists argued that content analysis alone presented two fundamental problems: (i) too much subjective interpretation on the part of the reader, and (ii) little consideration of linguistic architecture, which is problematic since language itself is a rule-based architecture.

From a creativity perspective, an additional argument is that readers encounter texts far differently than writers produce them. Fundamentally, reading is an act of interpreting, whereas writing is an act of constructing. Construction requires an understanding of structure. Yet nearly all feedback for established and developing writers comes in the form of reader criticism, feedback which often says more about the reader's psychology than the creative writer's needs (see [Maass, 2016](#), on reading as a process guided by emotional preferences). Feedback by expert writers and teachers is generally more helpful to the creative writer, but as [Blatt \(2017\)](#) demonstrated in the case of the novel, there is no reliable consensus as to what constitutes good writing. By comparison, CTA is a form of data science, which means the results are repeatable and thus tangible to the creative writer. A CTA can provide such information as verb counts (activity), how much narrative space a text is giving to which narrative topics, and the psychological characteristics of the protagonist, the narrator, or the entire text. Such detail might be of limited interest to a reader, but to a writer they are the equivalent of a songwriter's relationship to notes, chordal progressions, and arrangements. If applied accordingly, CTA has the potential to become a developmental tool in creative writing.

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Technology: Creativity in Chats

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Introduction

Chat Conversations

In recent years, almost everybody uses online communication and collaboration tools available through the Internet and Web, on a large diversity of devices including laptops, desktops, smart phones, and tablets. Among other tools, textual communication and multi-participants conversations using instant messenger (“chat”) became a practice that takes a lot of daily time. In addition to the advances in providing such communication tools, computer technology is now, on a permanent higher degree, including recent improvements in Artificial Intelligence (AI) technology. Though, even if AI applications perform nowadays remarkably in many tasks, and expectations are great that this technology will replace humans even in some intellectual activities, creativity is still a feature in which humans cannot be outperformed by computer programs. However, AI provides the means for empowering humans in their creative activities: AI-based Natural Language Processing (NLP) of the recorded conversations (the “chat logs” in textual format) can extract various data, such as creative ideas emerged during the conversation, features of participants relevant to the decisions on the composition of teams performing tasks involving creativity, and even hints for utterances to be emitted by an AI conversational agent that might foster creativity.

While many online conversations have only communication or socialization purposes, there are also two important domains where chat conversations can bring an important contribution: creativity fostering and creativity detection in Computer Supported Collaborative Learning (CSCL). The usage of conversations to foster creativity is often used in companies or in other work-related or educational settings in the form of brainstorming and its many variants. Usually these conversations are face-to-face but having them at a distance in the form of video-conferences or chat sessions is not a problem. Face-to-face discussions or video-conferences may be transcribed for further analysis, which in fact makes them closer, from the computer processing point of view, to chat logs. However, chat applications have a specific quality: they support the development of multiple discussion threads in parallel, especially if they have the facility to explicitly reference previous utterances in the dialogue (Mühlpfordt and Wessner, 2005). In speech-based conversations this is not the case, as only one speaker can take the floor and this feature makes it very difficult having more than one discussion thread at a given moment.

Creativity in CSCL Chats

CSCL is characterized by knowledge construction in small groups of students, face-to-face or chat conversations being one of the simplest and most efficient communication methods to support collaborative knowledge construction (Stahl, 2009). Creativity in CSCL chats should be supported in two ways: by designing assignments that foster creativity and by developing software tools able to identify creativity in the resulted chats, which allows analysis, feedback, and grading.

The development of software for analyzing CSCL chat sessions is very important in the context of the spread of Multiple Open Online Courses (MOOCs), in which several thousands of students follow online or recorded video lectures. In this context, automatic grading of assignments is mandatory as it is impossible to have enough human teaching assistants for manually assessing students’ homework. One possibility is to give students assignments to be solved collaboratively in chat sessions, but this solution should be supported by automatic analysis software tools, as described in this chapter.

Knowledge construction in CSCL chat sessions involves creative processes in at least two ways: discovering how to solve a given problem – for example, in mathematics (Stahl, 2009), and uncovering new features and relations regarding the concepts presented in the lectures. Chiu (2008) used the term “micro-creativity” to denote “an expressed idea that is new relative to the group members’ experiences” – that means a creative act performed in groups of students during CSCL sessions. In fact, one important dimension in education is to foster creative thinking skills in students. One way of achieving this goal is to design assignments that engage them in polemical discussions like, for example, debating about the concepts presented at lectures (Trausan-Matu et al., 2014). Moreover, chat environments should be enhanced with facilities for inducing inter-animation (Trausan-Matu, 2010) and flow state, the latter becoming in conversations a group flow state: “the most common place people experienced flow was in conversation with others. At work, conversation with colleagues is one of the most flow-inducing activities (...) Conversation leads to flow, and flow leads to creativity” (Sawyer, 2015). In this sense, chat systems having explicit referencing facilities enhance message production (Mühlpfordt and Wessner, 2005) and polyphonic inter-animation (Trausan-Matu et al., 2007), which may be compared with jazz improvisation, which generates group flow and group creativity (Sawyer, 2015).

The idea of engaging students in polemical discussions on concepts from the learning domain encourages them to take divergent positions. However, in order to obtain a constructive result, the discussions should be conducted towards eventually finding convergences that solve the introduced divergences. Such an approach has been used for a series of CSCL chat sessions that were given as a homework for undergraduate students in their senior year at the Human-Computer Interaction course at University Politehnica of Bucharest. The students had to discuss for 1–2 hours in groups of 4–8 participants, on a chat platform with explicit referencing facilities. Each of them had to choose a collaborative web technology (e.g., online forums, blogs, chats, wikis, and Google Wave) and were instructed to take the role of a company manager who should promote in the conversation their technology and, meanwhile, criticize the others’ technologies. They were told also that in the end they should work to find a solution to integrate the different technologies taking into account their different advantages in the idea to have a convergent step in the final part of the conversation that should integrate the ideas developed in the divergent phase (Trausan-Matu et al., 2014).

The assignment described above is, in fact, following the recommended divergent-convergent 2-steps schema for fostering creativity. One key factor that influences creativity is the presence of divergent ideas. As Mann and Cadman (2014) wrote, “There are no set answers to creative problems, but divergent thinkers can come up with a range of novel answers”.

Creativity from a Linguistic Perspective

One definition of creativity, which follows the above-mentioned divergence-convergence steps, is “the ability to see a challenge or a problem in a new light and to find solutions, which were not obvious” (Weston, 2008). Veale saw creativity from a linguistic perspective as “new and creative ways of expressing a given idea” (Veale, 2011), therefore, a different way of writing (and, implicitly, thinking) about given concepts. In this sense, creativity is directly related to the usage of metaphors and analogies. In addition to metaphors, other linguistic phenomena related to creativity were investigated, such as irony, humor, and similes.

Metaphors are used in a very important amount in our lives (See Metaphors). However, in CSCL chats it is hardly expected that students would use novel metaphors. A rather easier task related to identifying creativity in chats is the identification of potential new ideas, starting from the identification of the concepts in text and considering their semantic closeness to the domain of discussion. Such an approach is the subject of another section of this chapter.

Jokes and, more generally speaking, carnivalesque (Bakhtin, 1984; Trausan-Matu, 2010) also may be divergent steps, which can drive towards solving a problem. Such an example can be found in a chat of a group of students that collaboratively solve a mathematical problem (that was not solved individually by neither of them). An intervention of one of them that masquerades as mathematical reasoning (followed by utterances of “haha” by him and the others) was the spark that drove the group to find the solution of the problem (Trausan-Matu et al., 2007).

The identification of potential creative elements in texts may be done also starting from the formation of new words and, as some sociolinguistic studies showed, usage of a language which is perceived as “unplanned and unrehearsed, constructed on the hoof, whether it represents a brief, even fleeting (re)framing in which the interaction is temporarily keyed as artful/creative, or forms part of a more sustained creative interchange” (Maybin and Swann, 2007).

For both fostering creativity and CSCL knowledge building tasks using chats, statistical analysis tools and NLP technologies are very helpful for the identification of new ideas and, especially for understanding the creative characteristics of participants. An example of analyzing several creativity features with statistical methods for face-to-face conversations involved groups of four students engaged in solving a mathematics problem using a “code and count” approach proposed by Chiu (2008). Such an approach has two steps. First, utterances are manually annotated with codes, for example, speech or discourse acts. For example, in Chiu’s approach five dimensions of coding are used: (1) evaluation of the previous action (agreement, disagreement, ignore, introduction of a new topic), (2) knowledge content (new idea, repetition, or off-topic content), (3) validity, (4) justification, and (5) form of invitation to participate – which are a kind of speech acts. In the second step, statistics are computed (for example, how many new ideas were introduced) and, even complex data is extracted, as micro-creativity (for example, new ideas that are correct). The second step may be also the subject of machine learning in the idea of training a model, which may be used for automatically identifying micro-creativity in chats.

A Dialogistic Analysis of Creativity in Chats

The strong connection of conversations (and dialog, in general) with creativity was also emphasized by Mikhail Bakhtin: “Dialogically seen, information is not transferred, but, rather, produced. (...) dialogism could be seen as a type of creativity” (Lähteenmäki and Dufva, 1998). He introduced the idea that dialogism is a fundamental philosophical category and that dialog is omnipresent. A very important remark of Bakhtin is that truly creative words should contain more than one voice (voices, seen on a generalized sense, as ideas (Trausan-Matu et al., 2014)): “any literal, single-voiced word is naive and unsuitable for authentic creativity. Any truly creative voice can only be the second voice in the discourse” (Bakhtin, 1986). In addition to this multivocality, Bakhtin emphasizes the polyphonic weaving of voices, in an analogy with the musical case, where several voices co-occur keeping their own “personality” but achieving a coherent whole. Voices generate dissonances (divergences) which eventually are “solved” with consonances (convergences), thus the polyphonic phenomenon being a place for creativity.

The detection of “second voices” and polyphony is hard to grasp automatically with classical NLP tools. However, a semi-automatic approach may be implemented, and several applications have been developed starting from this idea, such as PolyCAFe or ReaderBench (Trausan-Matu et al., 2014). Moreover, patterns of divergence and convergence (Trausan-Matu et al., 2007) may be identified as indicators of a polyphonic weaving.

PolyCAFe was developed for analyzing the individual and group contributions of students engaged in chat conversations in CSCS assignments of the type discussed above in this chapter. It uses NLP techniques for detecting the concepts from a chat. These are presented to the user (see Fig. 1), thus supporting her/him to identify new concepts (“second voices”), with creative potential. For example, in Fig. 1, the concept “post” may be identified as a “second voice”, which can drive to creative ideas by inter-animation with the “primary voices” (wiki, blog, forum and chat) – the concepts that were imposed as subjects of discussion.

PolyCAFe has also graphical visualization facilities, which may be used for analyzing how the “second voices” manifest along the chat (see Fig. 2). Moreover, the system, starting from the polyphonic weaving, computes a measure of inter-animation (Trausan-Matu et al., 2014), whose evolution in time reflects the variation of collaboration (see the graphical representation in the middle

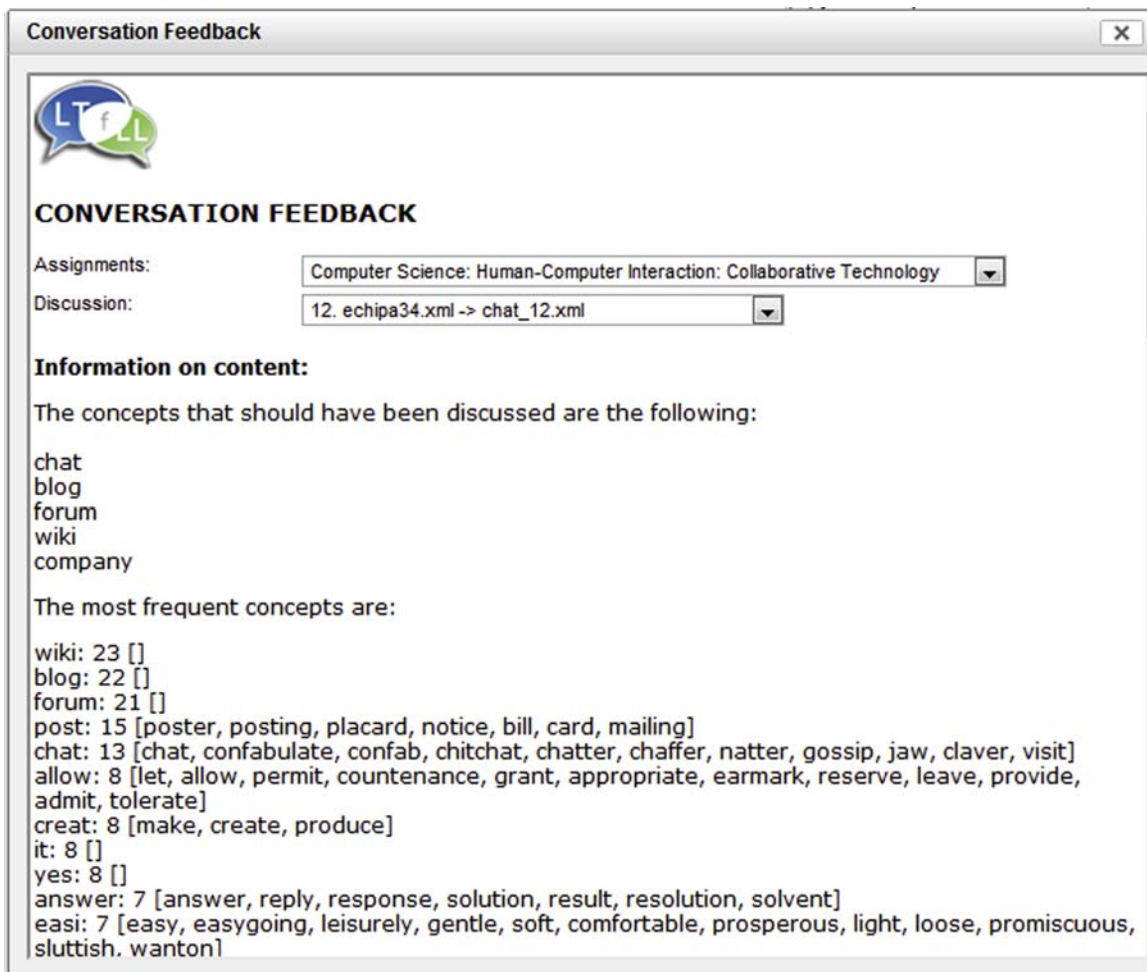


Figure 1 Feedback provided by PolyCAFe about frequent concepts.

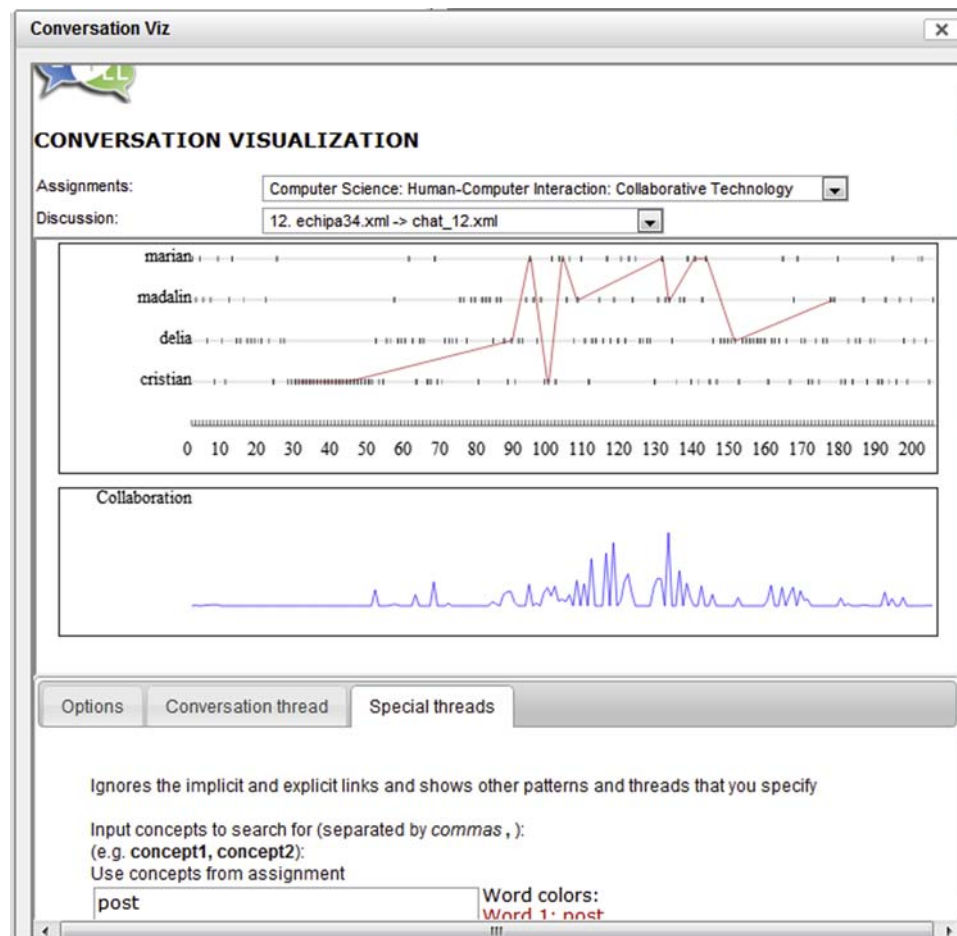


Figure 2 The evolution of the usage of the “post” concept, candidate for a “second voice”.

of Fig. 2). The zones with a high collaboration/inter-animation are zones in which group flow may have occurred and, consequently, their utterances might contain creative ideas.

Corpus-Based Creativity Identification in a Group of Related Chats

The method presented above is useful for analyzing a single chat conversation. However, if multiple such conversations that debate similar concepts are available (as is the case in the context of MOOCs), then another type of analysis can be performed. In this case, the content uttered in each conversation from the corpus may be analyzed with the purpose of identifying significant similarities and differences between them. The intuition behind this analysis is that the similar parts that are observed among the chats represent common, ordinary knowledge, that is known and accepted by most participants and thus cannot be considered creative. In the same time, the observed differences – elements that are not common and are presented only in a few chats – represent intended deviations from the commonly accepted concepts. These deviations may be treated as signs of creativity or divergent thinking, considering that linguistic creativity is linked to the unpredictable departure from regular rules. Practically, the main assumption of this method is that “creativity can be linked to differences in the participants’ discourses, rather than to creative manifestations in language, which are difficult to identify and assess” (Chiru and Rebedea, 2017).

Thus, a software application was developed with the main purpose of identifying the segments containing ideas that are not usually generated. This is achieved by comparing the current conversation with lots of other discussions on the same topic (the more such conversations are available, the more reliable and interesting results, related to creative talk, may be generated). To this purpose, the content of the current conversation is analyzed to detect new (creative) ideas and then to see what happened to them – if they were subsequently exploited (the conversation insisted on those ideas) or lost (used once and never repeated) (Chiru and Rebedea, 2017). This application is a first step in supporting creativity in chats by highlighting the novel concepts present in the corpus (*new ideas*) and considering them to be creative and also by identifying topics that could have become important, but they were forgotten during the debates (*lost ideas*).

However, not everything that deviates from the standard is creative, some of these deviations could be simply off-topic and should be treated as such. Therefore, a method that could discriminate between the two possible scenarios should be devised. Such a method could compare the content found in the candidate areas (that show significant differences compared to the other chats) to the main topics that should have been reached in the conversations. If the concepts are semantically connected to these topics, then the areas are on-topic and should be considered creative. Otherwise, their content is off-topic and the areas may be simply ignored.

To demonstrate the viability of this method, [Chiru and Rebedea \(2017\)](#) applied the developed application on a subset of the corpus of chat conversations carried by senior Bachelor students involved in the CSCL task presented in a previous section. The dataset consisted of 25 similar chats, having in total 82176 words in 8798 utterances, with a vocabulary size of 5948 distinct words. In this research, an idea was considered to be a specific concept, which can be expressed by a word or a group of semantically connected words (the lexical chain of that word). To enable the detection of creative ideas, first the vocabulary of the entire dataset (containing all the ideas from the chat corpus) was extracted, along with the words' frequencies considering all the chats from the corpus.

Once all the ideas (concepts) in the corpus were identified, the system tracked their developments, the reactions they attracted and the conclusions that were drawn based on them and each utterance was labelled according to its type. Then, starting from the previous analysis, a second part of the application was built, which proposed a model for the evaluation of the participants' typology using the labels of their utterances and affective factors (e.g., if a participant is negative or positive throughout the conversation). This part of the application was built based on the premise that group constituency (participants' typology) is an important factor in developing creative conversations and that the outcome is also influenced by emotional/affective factors. Thus, the authors considered that knowing what kind of participants lead to different creativity levels might be important and devised a way to visualize each participant's typology.

Lost Ideas Identification

Lost ideas are the rare concepts that were found in only a small number of chat conversations. From the vocabulary, the concepts that were found only once were kept for analysis as candidates for lost ideas. This can be considered as a hapax legomenon for the concept space created from the entire corpus of conversations. To filter out the off-topic content from this list, the authors verified if the utterances where they were found contained (or not) other on-topic concepts. If these utterances had on-topic content, the concepts were kept and labelled as lost ideas. Otherwise, the rare words were labelled as off-topic, and the corresponding utterances as well.

This approach could have been extended to other rare words, with a larger appearance frequency, but, in the present context, this already led to a large number of concepts labelled as lost ideas (161 different concepts). Most conversations from the corpus contain lost ideas in about 1.5%–2% of the total number of utterances, with only a few conversations (4 out of 25) having a larger percentage of lost ideas (more than 4% of the total utterances from these 4 chats contain lost ideas).

The application shows each rare word that was found and was labelled as a lost idea and the user has the possibility of selecting the ones that (s)he is interested in. When a selection is made, the application shows the name of the chat in which that word was found, the participant who uttered it and the content of the utterance (see [Fig. 3](#)).

New Ideas Identification

New ideas are represented by concepts or combination of concepts with high frequency in a small number of chats. Thus, candidate concepts for new (creative) ideas were the ones with a frequency larger than the chat average, but that appear only in a small number of chats. Since these new ideas are interesting to be captured (from a creativity point of view), for each candidate utterance, the system extracted the pattern involving the concepts of interest, in order to verify if similar situations were also present in the other chats from the corpus. Thus, a window of variable length was considered involving the co-occurrence of relevant concepts (*concept_1* [*] *concept_2*) and consisting only of nouns and adjectives and then the utterances from all the chats from the corpus were investigated to see if they contain any such patterns, with a maximum deviation of a word (added or missing).

Using this methodology, the application was able to identify 95 patterns for new ideas, which were used afterwards to extract 2258 utterances from the corpus that matched at least one of the patterns. Out of the 95 patterns, 82 consisted of unique combinations of concepts, while the rest (13) had the same combination of concepts as one of the 82, but with different window sizes (different number of words in between the concepts). The window sizes varied from 1 to 9 words between the two concepts representing the pattern. The average window size for the identified patterns was 2.93 words, while for the utterances extracted based on them was 2.79 words, which means that, in average, the concepts investigated were separated by 3 other words. The number of new ideas was in most chats below 40% of the total number of utterances, with most conversations containing new ideas in about 20% of their utterances.

The application displays similar information as in the case of the lost ideas, as shown in [Fig. 4](#).

One of the authors' objectives was to determine whether the creative ideas detected automatically in chat conversations using this method are linked to the conversations which have a better general assessment from human tutors (which are domain experts). Thus, they verified whether the number of creative ideas (the sum of new and lost ideas) identified by the application in a chat can be considered as a proxy for a good quality conversation as assessed by tutors that take into account several different factors, including the content and the quality of the collaboration ([Trausan-Matu et al., 2014](#)). To this aspect, they computed the correlation

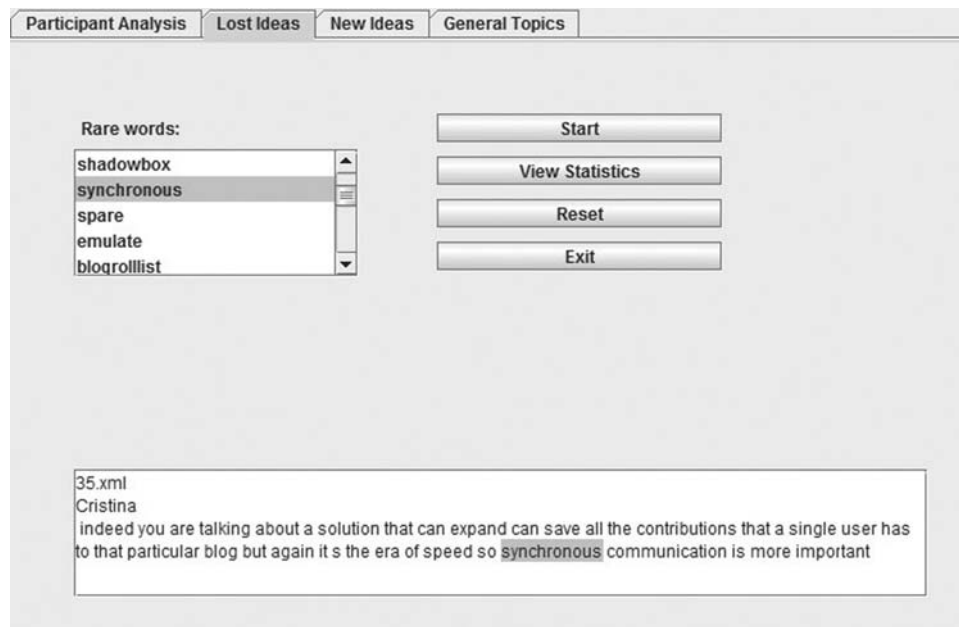


Figure 3 The display of lost ideas in the corpus of chat conversations.

between the number of creative ideas identified in a conversation and the quality score for that chat, as it was evaluated by domain experts. This test showed that this correlation is very high ($r = 0.74$), close to the inter-rater agreement scores on chat quality ($r = 0.86$), suggesting a strong connection between the detected creative ideas and the manual assessment of chats by the domain experts.

Identification of Ideas and Reactions

In addition to the creative ideas identified using the methodology presented above, [Chiru and Rebedea \(2017\)](#) also defined another four utterance categories, to be used in the evaluation of the creativity of individual participants: *reactions* (approvals, disapprovals or continuations of previously stated ideas), *conclusions* (discourse markers that are specific to conclusive utterances, such as *so*, *in*

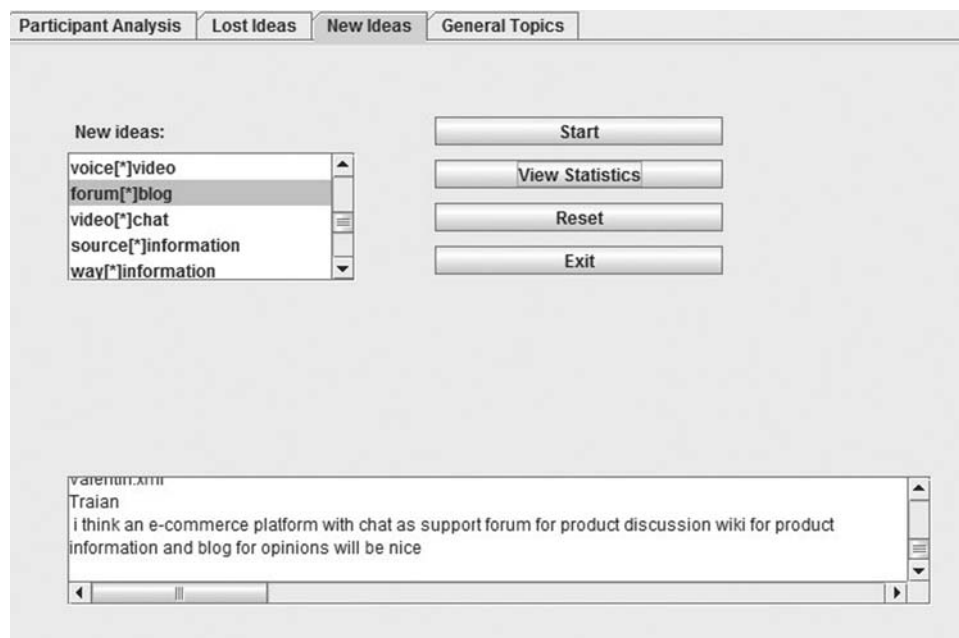


Figure 4 The display of new ideas in the corpus of chat conversations.

conclusion, or to *sum up*), *developments of conclusions or ideas* (if the previous utterance contained on-topic concepts, its development should also contain words from the same semantic field), and *ignored utterances* (off-topic content and social noise, usually present at the beginning and ending of each chat).

Participants Analysis

Once each utterance was classified in one of the five classes from the above list, the system used these labels to evaluate in which typological category each of the chat participants might fit. This analysis is based on the belief that productivity in interactive groups is influenced by the participants' opinions regarding how they are perceived by their peers. Thus, the participants were evaluated in terms of their *leadership*, *development* (providing ideas related to the debated subject, but without introducing new concepts), *innovation* (bringing new concepts into the conversation), *negativity* (being against the ideas proposed by the other participants and endorsing this position with valid arguments), and *conclusive* (being the one drawing the conversations' conclusions) skills that they proved to have in their utterance. A participant received leadership points for having the most ideas about the debated topic, for managing to convince the others that the ideas in which (s)he believes are the best or for having her/his own ideas approved (or at least not disapproved) by the others. The off-topic utterances and the ones that did not contain anything meaningful to the topic of the conversation were clustered in another class – *others*.

Since the system was unable to (automatically) determine the relevance of a significant part of the utterances from the chat discussions' dataset, the *others* class contained the highest percentage of utterances (21% of the whole corpus of chats). From the identified skills, the highest score was received by the *development* category (20.5%), which is somehow expected as, during their undergraduate studies, the students are prepared to solve different problems, which involves reasoning and developing ideas given by a supervisor (which in this case, were the teachers). The next highest score typology that was present in the chats was *negativity* (19.5%), this fact being explained by the imposed topic of the chats: the students were asked to find the flaws of different technologies and, after that, to find a way to overcome those problems. Thus, in this context the *negativity* typology is influenced by and can be easily linked to the divergent step in the collaborative task at hand. *Innovation* (18.5%) was the subsequent typology, considering the obtained scores, and again this might be influenced by the nature of the conversation, that pushed the participants into thinking about various problems and solutions for them. An alarming low representation in the chats was seen for the *leadership* skills (5.5%). This low value might be partially explained by the fact that they had to work as a team to solve the task and there was no need for any participant to take the lead in the conversation. However, the low value should be an alarm signal, showing that during Bachelor studies, the students are not encouraged enough to exercise this kind of skills.

For each of the selected chats, the developed application displays one chart that has the participant's name on the horizontal axis and their percentages for the different typology types on the vertical axis, as shown in Fig. 5.

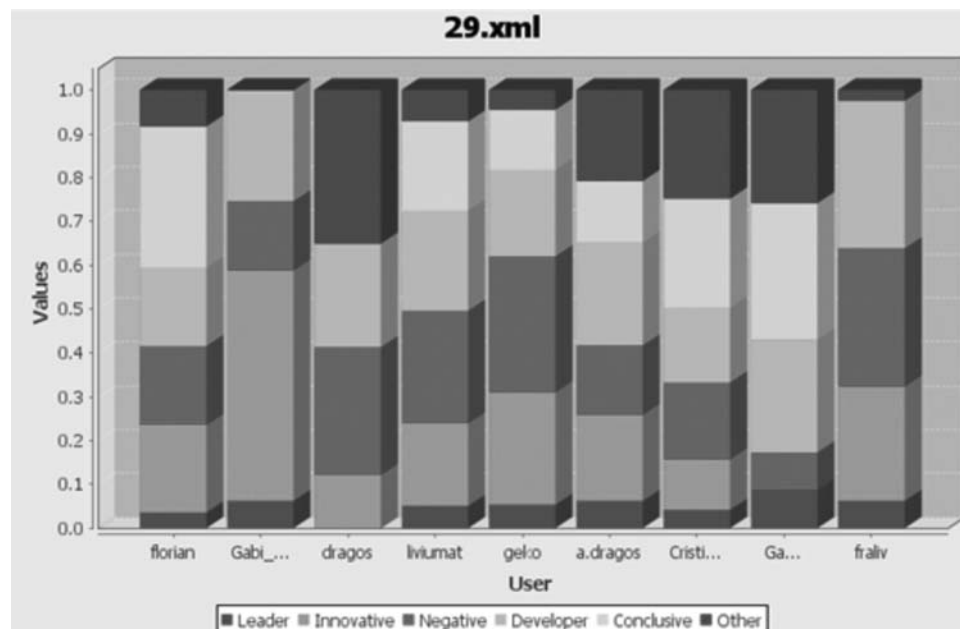


Figure 5 The display of participants analysis in a chat conversation from the corpus.

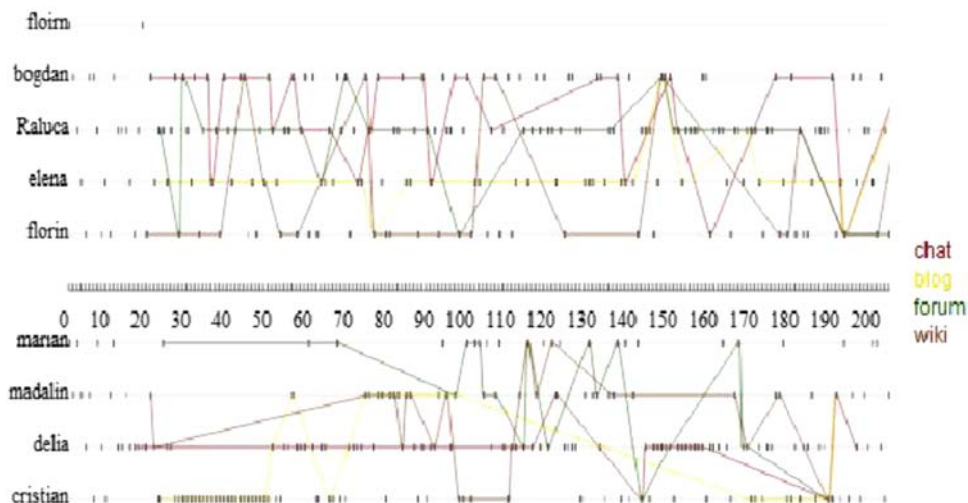


Figure 6 Two chats with different degree of inter-animation.

Results and Discussions

Discourse creativity is very complex and difficult to determine automatically. The tools presented in this chapter can be used by researchers and teachers to analyze chat conversations with multiple participants engaged in CSCL tasks in order to automatically determine some creative aspects, such as polyphonic discourse, inter-animation of ideas in a single discussion, or creative (lost and new) ideas by considering a larger dataset of chats on the same topic. PolyCAFe can be used for analyzing chat conversations to identify the main topics of the conversation, second voices (as discussed and shown in Figs. 1 and 2 above), and inter-animation of ideas starting from the polyphonic model. For example, in the chat from the top of Fig. 6 there is a greater degree of inter-animation than in the bottom chat. However, the assessment of creativity is performed by the user, either a researcher or a teacher, using the facilities of the developed tool. On the other hand, the corpus-based analysis of chat conversations provides an automated method to detect creative ideas in a conversation by comparing it with the utterances from several other chats having the same discussion topic.

The presented corpus-based analysis of creativity in chats has been fully automated for processing chat conversations with multiple participants engaged in the CSCL task discussed in this chapter. The developed tool can detect creative ideas in a conversation by analyzing a large corpus of chats that have the same topic, consisting of several groups of students working on the same CSCL assignment. Starting from the idea that creativity in language and discourse ought to be reflected by the differences in the participants' discourses and lexis, the tool analyzes the usage of rare relevant concepts throughout the entire corpus. These rare concepts are considered creative, as they are an intentional deviation from the standard concepts debated in several different chats from the corpus.

The tool and method of analysis described in this chapter make use of a corpus of similar texts to compute insights related to the concepts that are on-topic, but appear very sparse in the corpus, as compared to concepts that are more popular in the dataset and thus cannot be considered creative. This shows that discourse creativity can be automatically detected by analyzing the differences between discussions (creative ideas) and excluding similarities (regular/frequent ideas).

When investigating the creative ideas identified by the application, it is important to study the number and distribution of creative ideas in the entire collection. This can be seen as a quantitative indicator, as only a limited number of chats should be highly creative (e.g., contain a large number of creative ideas). Looking at the number of lost and new ideas in all chats from the analyzed corpus, it can be seen (in Fig. 7) that the distribution of creative utterances follows closely a slightly positive skewed Gaussian

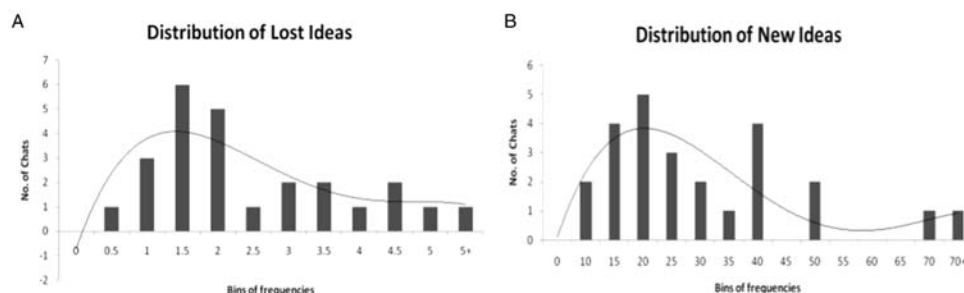


Figure 7 The distribution of the frequency of lost ideas (A) and new ideas (B) in the entire corpus of chats.

distribution, highlighting that most conversations have a rather small number of creative ideas and only a limited percentage of the chats are more creative with regard to the number of discovered creative ideas.

The main difference between lost and new ideas is that the former are concepts that are related to the topic of discussion and were brought to the discussion by the participants, just to be either ignored or not accepted by the group. This means that either the students did not fully understand them, or they were not considered relevant for the debate. At the same time, the new ideas discovered by the application share important information about the connections between different concepts made by students, based on the learning materials. Further analysis of the new ideas discovered in the chats highlights that they were well connected with the conversation's-imposed topic of debate, which suggests two points:

- The developed application can be used to identify and extract patterns that are relevant for the topic of debate (the patterns capture relevant information from the text).
- As a large majority of the discovered new ideas are on-topic, the students followed in general the assigned topic for debate, without concept drift or abusing on off-topic talk.

A manual inspection of the new ideas identified by the system can also bring information about concepts that were not well understood by the students, as they are not connected to any other concepts in any analyzed conversation. For example, [Chiru and Rebedea \(2017\)](#) learned that the concept "wiki", which was one of the most relevant topics for the debate, was not found in any of the discovered patterns forming new ideas. This means that the students have not connected the "wiki" concept to other relevant concepts, showing that either they had difficulties in understanding the concept or in finding its proper relationships with other concepts relevant for the task. On a similar note, the frequency of the patterns in which different concepts were found might reflect the students' position regarding a preferred solution for the task at hand, when multiple choices are available. In the presented dataset, this examination showed that students were prone to consider that a *blog* combined with an online *forum* are the best instruments for information sharing and collaboration in a large company.

At last, some deeper insights were searched on the correlation between the number of creative ideas in a chat and the quality scores assigned by domain experts regarding the content of the discussion and the collaboration quality. An important observation is that the number of lost ideas is better correlated with the tutors' score on content ($r = 0.71$) than the number of new ideas in a chat ($r = 0.58$). On the other hand, from the collaboration point of view, new ideas achieve a higher correlation ($r = 0.81$) than lost ideas ($r = 0.58$). Thus, even though lost ideas are concepts which were not fully investigated in the chat, the fact that they were present only in a small number of chats indicated that the participants to those chats posed problems that the others were not aware of (or did not consider them to be important), suggesting a better understanding of the concepts and thus leading to a better evaluation by the tutors with regard to the content quality of the chat. The other point that was observed (high correlation between new ideas and collaboration) was somehow normal, being supported by the fact that in order to become a new idea, a concept must be intensely debated within the chat, which most of the time required the involvement of multiple participants, and thus, collaboration.

Conclusions

This chapter presented how creativity can be supported and detected in CSCL chats. Several methods and software tools were described that may be used for determining some creative aspects from chat conversations. One of them was PolyCAFe, which was designed to support researchers and teachers in analyzing CSCL chat conversations with multiple participants to understand the most important concepts in the discussion, potential creative ideas, inter-animation of ideas, and the overall quality of collaboration. The second application was a corpus-based tool for extracting creative ideas and the typology of chat participants starting from these ideas/concepts. This program requires a large collection of chats that have the same topic and uses statistics computed on the entire dataset to identify rare concepts and co-occurrence of concepts.

Software tools that can identify creative elements in texts and conversations automatically, or just support the user in a semi-automatic analysis, have a wide range of applications. This list includes but is not limited to support in brainstorming sessions, helping writers in search of inspiration for the right wording, automatic essay grading, or generating interesting expressions in natural language generation systems. However, in order to reach such goals, it is still needed to improve the methods for detecting utterances that are on-topic and how these utterances are connected with the proposed subject of the conversation. This way, further research will be able to provide a more complex analysis of creativity and to find more interesting information that, for the moment, remain hidden in the text.

The presented creativity-based method for classifying participants' utterances into different categories (e.g., ideas, reactions) and for defining participants' typologies starting from them can also provide an initial step for a better-informed group formation for CSCL tasks that considers the creative typology of each participant. This approach might also be used to support the analysis of collaboration/communication practices and thereby the provision of more adaptive external collaboration scripts.

In the end, the presented corpus-based application might also help Veale in his quest for retrieving creative (fresh or unusual) expressions that have the same meaning as the query ([Veale, 2011](#)) or the researchers investigating how people decide the choice of words when making up a novel noun-noun compound.

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Technology: Gaming

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Introduction

Technology has revolutionized gaming, and now people play more games than ever. Digital gaming technologies are ubiquitous and abundantly available, being both a feature of digital communication media—such as smartphones—and, in themselves, a forum for digital communication. Because of the relative novelty of this condition, it is still unclear the magnitude of the psychological and cultural influence that easy access to digital gaming technology will have on society. There are, perhaps, causes to fear, as digital isolation and disconnection are becoming known as harmful consequences of engaging with this technology; there are also reasons to hope that this technology will provide an enduring benefit to humanity, especially demonstrated in the observation that there are already early signs of the capacity for digital gaming technology to significantly facilitate and activate creative engagement.

The purpose of this article is to articulate multiple frameworks for understanding how the concept of long-term engagement with play, games, and gaming (that is to say, playing games) can provide a broad vantage to think about the creative benefits of these activities, and, more specifically, the creative benefits of digital gaming in the modern world. The first section will present a historical discussion of the theory of play culminating in discourse about modern efforts exploring the benefits of gaming and the extent to which current research can illuminate a potential overall benefit to. This discussion will also focus on the extent to which the effect on creativity is demonstrative of more limited positive effects on cognition, emotion, social interaction, and motivation.

Then, drawing from the logic of play theory—most directly, from Huizinga's (1938) fundamental observation that games will, at the most basic level, influence the *self* and *society*—the discussion will draw from extant theories of creative behavior to articulate two complementary means by which to conceptually model the positive effect of video gaming on specific types of creativity: the first focusing on the theory of personal creativity; the second focusing on the theory of collaborative creativity. Each of those sections will describe how the theory provides insights about current research, culminating in suggestions for potential areas of future study.

From Video Games to Creativity: Gaming, Play, Costs, and Benefits

Games and gaming have increasingly advanced to the forefront of many peoples' lives. This is seen clearly in the spectacular rise of video gaming in recent history. Granic et al. (2014) pointed out that by the end of the first decade of the 21st century, more than 90% of children and adolescents had indicated that they played video games, contributing to a titanic \$25 billion industry that has overtaken forms of entertainment based on older technologies. Digital gaming has emerged as a social, cultural, and economic juggernaut, pervasively influencing the landscape of daily experiences.

Trends in the cultural and technological evolution of video gaming now appear quite quickly and tend to be vigorously disavowed in the aftermath. For example, a recent craze for Fortnite (see Lindberg, 2018 for an account) has cooled, and gamers are entering into a new epoch of eSports with the recent expansion of interactive platforms like twitch.tv (see Lecourt, 2018 for an account). As time passes, these developments, like many before them, will seem quaint and dated. But invoking this sense of impending obsolescence is, in fact, the point: It is precisely from knowing that games like Fortnite and gaming platforms like twitch.tv will be innovated, altered, rebranded, and possibly overtaken by competitors that offer the tools to consider the more salient historical, social, and psychological dimensions of gaming.

That is to say, apprehending the transient nature of games can enhance understanding of the enduring nature of play. Yesterday's *Royal Game of Ur* (see Scott, 2017) may have given way to today's battle royale-styled digital competitions, but players never seem to be tired of seeking the next new game. And, here, there are tangible reasons to believe that this understanding of inherent transition is a valuable perspective to have: Consider, by way of example, the legacy of the Nintendo Corporation, evolving as it did over a period of more than 100 years from the production of handmade paper hanafuda cards during the Meiji era to its current state as a leader in the development of digital gaming technology (see Caruso, 2014 for discussion).

It was Johan Huizinga who, in his (1938) book *Homo Ludens*, first critically examined games and playful activities from a broad variety of cultures and historical sources available to him to get an understanding of play and the extent to which it permeated

society. Huizinga came to believe that, above all other activities, play was the essential element of human culture; in his words, he understood “play” to be

the accompaniment, the complement, in fact an integral part of life in general. It adorns life, amplifies it, and is to that extent a necessity to the individual—as a life function—and for society by reason of the meaning it contains, its significance, its expressive value, its spiritual and social associations, in short, as a culture function (1938, pg. 9).

Huizinga took the role of play in human experience to be vast and expansive, encompassing cultural domains inclusive of the sacred, the mystic, the mysterious, and also those derived from ordered principles of social engagement: law, war, academic debate, poetry, art, and even, by way of entropy, politics. For the most part, Huizinga believed play to be a benefit to humanity, especially in spiritually ascendant esthetic experiences, as in poetry, music, and the visual arts (Huizinga, 1938, pp. 158–169).

Later, scholars of play, Roger Caillois among them, would not always paint such a rosy picture. For Caillois, play had descending, negative aspects as well. Play, in his estimation, did not contribute to sacred mystery, but instead exhausted it; furthermore, play was unproductive and contributed to “pure waste: waste of time, energy, ingenuity, skill, and often [...] money” (Caillois, 1958, pp. 5–6). Each of his four types of play—agon, alea, mimicry, and ilinx—was associated with a type of “corruption,” such as “violence” in games taking the form of agon, “superstition” in alea, “alienation” in mimicry, and “alcoholism” in ilinx games (Caillois, 1958, pg. 54).

More broadly with respect to the issue of corruption, Caillois presaged not only the potential for the influence of the “real world” to subvert play but also the conditions under which play would be employed to negative consequence:

Corresponding to each of the basic categories there is a specific perversion which results from the absence of both restraint and protection. [...] [T]he tendency to interfere with the isolated, sheltered, and neutralized kind of play spreads to daily life and tends to subordinate it to its own needs, as much as possible. What used to be pleasure becomes an obsession, and what was a pastime is now a passion, compulsion, and source of anxiety.

Caillois (1958, pg. 44)

And, indeed, in the wake of the intense rise of video gaming culture, it is not difficult to find real challenges very much like these facing a new generation growing up immersed in modern gaming technology: issues of gaming addiction, loneliness, and isolation amplified by the capacity that these games now have to absorb players’ lives in anxious compulsion (as in Stockdale and Coyne, 2018).

For this reason, there is an awareness of the potential costs of long-term engagement with video games that informs contemporaneous research into the psychological effects of gaming on individuals and social groups. Furthermore, there is an obligation, in light of those costs, to articulate the benefits of deep engagement with gaming. Granic, Lobel, and Engels, whose (2014) article was a direct attempt to categorize the type of benefits inherent to video gaming, framed their need to explore the topic with the argument that “in order to understand the impact of video games on children’s and adolescents’ development, a more balanced perspective is needed, one that considers not only the possible negative effects but also the benefits of playing these games” (2014, pg. 60).

Starting from this question of the benefits of video gaming, Granic et al. (2014) were able to find evidence in support of multiple kinds of positive influence of video gaming: those being (1) cognitive effects, (2) social effects, (3) emotional effects, and (4) motivational effects. Within each category of effect, the findings of one or more empirical studies cited by the authors were demonstrated as an outcome, such that an aggregate group of effects was formulated by convergence of multiple sources. In this way, for instance, the cognitive benefits of gaming were composed of influences on spatial reasoning, visual processing, attention, and problem-solving skills. Likewise, the effects of video gaming on emotions were conceptualized as improvements to mood and satisfaction, as well as facilitation of the flow experience. On reflection, Granic et al. (2014) found themselves to be “particularly inspired by the potential that these games hold for interventions that promote well-being” (2014, pg. 71).

As researchers begin to conceive of the benefits of gaming in the empirical sense, the research started connecting more deeply to a theoretical understanding of the creative nature of play. It was in the character of this type of effort that Jackson and Games (2015) integrated their own prior research findings into the framework of benefits proposed in Granic et al. (2014); they described a more fundamental basis for the canons of evidence promoting the benefits of video gaming: These benefits were, across all four previously identified categories, indications of a positive influence on the creativity of gamers. In their words, Jackson and Games (2015) identified creativity as a summary benefit of gaming “mediated [by] beneficial cognitive, social, emotional, and motivational effects” (2015, pg. 30).

Bowman et al. (2015) advanced a similar line of reasoning, effectively tracing a history from Huizinga’s work through the study of play to the incorporation of the topic into the study of creative thinking skills. They then elaborated their position by reframing the causal model, postulating that “part of the reason why play is so successful at stimulating creative thinking is because play is a creative process in and of itself” (2015, pg. 43). For them, video games represented a new paradigm in the study of creative play, in that, unlike games that had existed in prior eras, video game technology provides spaces that enable multiple game types in a rich interactive environment that could not have existed more than a few decades ago (2015, pp. 47–54).

If a benefit of gaming is increased creativity—and there is a growing body of evidence to support this—what comes next? How, does the procreativity perspective inform the role of modern digital gaming as a reasonable investment of time and attention, above and beyond the simple joy that healthy play can afford?

Perhaps the most useful vantage is the most theoretically parsimonious: That, following the most fundamental insight of [Hui-zinga \(1938\)](#), scholarship should primarily cultivate understanding for the principle participants of play, meaning a direct, mindful focus on how play influences the creativity of the *individual* and larger *society*. The following sections will include a discussion of the form, context, and background of personal and collaborative models of the creative benefit of video games and will highlight the potential contributions of creativity theories as they apply to the individual and to the society, both in organizing the grounds of evidence into larger constructs for analysis and in proposing avenues for further investigation.

Gaming as a Benefit to the Individual: Personal Creativity

In his article, *Personal Creativity*, Mark [Runco \(1996\)](#) described a conceptualization of creativity applicable to individual creative behavior, manifested as desire to “transform the objective world into original interpretations, coupled with the ability to decide when this is useful and when it is not” (p. 4). Transforming (in other words, adapting or accommodating) and interpreting ideas and experiences held a central place in Runco’s theory, driving the mindful discretion, as well as directing the intentions of creative individuals. This type of “idea transformation” was associated with problem-solving and problem identification and a state of deep immersion in a project ([Runco, 1996](#), pg. 5).

Embedding Runco’s construct of idea transformation and the language of personal creativity into the discourse concerning the creative benefits of gaming technology generates a modified perspective that more deftly incorporates [Granic et al. \(2014\)](#) evidence of benefits to cognition and emotion more seamlessly with extant creativity research. The indicative label “transformation” is used by scholars to typify a variety of mental capacities, many of which characterize a high degree of personal interaction with ideas, incrementally forming the substance and foundation of knowledge acquisition. [Alexander et al. \(2011\)](#) situated transformation as an essential component of their process-based operationalization of higher-order thinking skills, defined as “Mental engagement with ideas, object, and situations, in an analogical, inductive, deductive, and otherwise transformational manner that is indicative of an orientation toward knowing as a complex, effortful, generative, evidence-seeking, and reflective enterprise” ([Alexander et al., 2011](#), pg. 53).

Here, among the constellation of cognitive skills that constitute higher-order thinking, transformation is contributory to a “deep processing” approach, one that extends—very much in accord with Runco’s position in the theory of personal creativity—beyond surface-level procedures, and into efforts to “understand meaning, question the author, justify evidence, and relate material to personal experience” ([Alexander et al., 2011](#), pp. 52).

But does the available evidence support the inference that cognitive transformation might help explain the positive influence on creativity of video gaming? This was an issue broached, if obliquely, in one of the few early studies empirically investigating the potential benefit to creativity of video gaming: [Jackson et al. \(2012\)](#) gathered responses from gamers to figural and verbal creativity tasks and analyzed those correlations for a pattern of relationship. They discussed in their conclusion the possible effect of “computational thinking,” defined therein as a “broad range of mental tools and concepts [...] that help people solve problems, design systems, understand human behavior, and engage computers” (p. 374).

While their tone was tentative—an especially salient point, given that their findings were based on correlational observations—this group did nominally credit that “computational thinking is related to creativity, and that together they facilitate interest and performance in the virtual world—the world of video games” ([Jackson et al., 2012](#), pg. 374). Their description of “computational thinking” relates to the constituents of “deep processing” because computational thinking has been demonstrated on other occasions to closely relate to creativity through cognitive transformation ([Veale et al., 2006](#)). However, given the nature of the findings, perhaps the best framework for understanding would be to consider both potential components of a more complex model.

And so, if the current evidence can support that video gaming benefits transformational thinking, what value might be derived from the elaboration? This question returns the discussion to an examination of the practical dependencies of higher-order cognition illuminated by [Alexander et al. \(2011\)](#) and raises the issue of the emotional benefits as a partial contribution to creativity enrichment driven by enthusiasm for video gaming.

In [Alexander et al. \(2011\)](#), strong statements were made underlining the perspective that experiential interactions amplify their meaning and long-term utility when a person employs higher-order thinking, but that higher-order processes do not occur on their own or without sufficient reason—that they can emerge only when the developmental, social, and, most importantly, dispositional characteristics of the individual align in purpose to promote higher-order engagement, transformational thinking, and deep processing. By highlighting disposition, [Alexander et al. \(2011\)](#) were, in essence, encouraging the notion that individuals must find an emotional connection to a topic, that they must have a “dispositional orientation,” to invest in higher-order thinking: In fact, a sizable portion of their writing was devoted to discussing the challenges of appealing to the emotional and dispositional orientations of individuals, examining as they did the dimensions of “what,” “who,” “where,” and “when” (2011, pp. 56–76).

Runco viewed emotion to be a necessary characteristic of personal creativity; “Creativity will not be well understood just as a cognitive mechanism; it is also emotional or affective” ([Runco, 1996](#), pg. 23). However, Runco struggled to offer a definitive account of the effect of emotions, which he presented as “extracognitive bases” on personal creativity; instead he posited a scatter-shot of possible influences, ranging from the effects of autonomy and nonconformity to mindfulness and, at the extreme, to

deviance (pg. 23). He proposed that transformative interpretation depended on a person's emotional perspective, that "problematic" circumstances would create "anxiety," complicating interpretation, while a contrasting "enjoyable" view of a situation would not interfere, being instead thought of as a "challenge," and would thereby better promote transformative thinking (Runco, 1996, pp. 7–8).

Jackson and Games (2015) provided a direct argument for the effect of positive emotions on creativity: Video games are gratifying, they improve mood, they aid in relaxation, and diminish anxiety, all of which contribute to a net facilitation of creative conditions, such as inspiration and challenge (2015, pp. 24–25). In addition, they stated that video games enhance creativity through their ability to induce a "flow state" (Jackson and Games, 2015, pg. 24), which Bowman et al. (2015) described as "improved focus on the task, a sense of active control, the merging of action and awareness, a loss of self-awareness, a distortion of the experience of time, and [...] experience [of] the task as being the only necessary justification for continuing it" (Bowman et al., 2015, pp. 45–46). That the flow state can augment individual creative thinking is uncontroversial in the field of creativity research, and its effectiveness in this area is well documented (Granic et al., 2014, pp. 6–7).

So, to offer a brief summary, there is some justification based on extant research for taking up the perspective of personal creativity as a frame to evaluate the benefits of creativity afforded by video gaming through the lens of idea transformation and the uniquely motivating power of the video gaming experience. Additionally, based on the theory of personal creativity, there is reason to believe that these aspects of creative benefit—the cognitive and the emotional—are, even if separable in the abstract, inseparable in practice, as positive dispositions lay the necessary groundwork for deep processing. This enriches understanding by more concisely operationalizing (1) the overall character of individual creative outcomes expected from video gaming, (2) the type of thinking skills that might best benefit from video gaming, and (3) the vital import of emotion, and most especially flow, in affecting dispositions such that individuals will want to engage in creative cognition.

Where might further research go from here? An obvious direction, as the personal creativity interpretation of the creative benefits of video gaming is, at present, not yet verified by experiment, would be to explore the components of the theoretical model. One avenue might be to use empirical methods to structure a mediational model to assess the effect of flow on transformational thinking on individuals with contrasting histories of video game use. An alternative approach might be to use qualitative methods as a means of capturing a sense of the flow experience among a group of video game enthusiasts and, moreover, to relate those experiences to how those individuals use transformational thinking—in what social contexts and referencing what domains. One might also make use of a mixed-methods approach, starting with qualitative research investigating the expression of the flow and idea transformation phenomena, and complementing that canon of evidence with quantitative data looking at correlations and linear relationships among each construct.

Gaming as a Benefit to Society: Creative Learning Environments

In his article *Paradigms in the study of creativity* Vlad Petre Glaveanu in 2010 set forth the principles of a perspective on creativity that positioned the sociocultural character of the creative endeavor as a central focus. Proposing an alternative to the individualistic attributions of creativity and creative potential that have long dominated the field, Glaveanu instead recast creativity as an inherently collaborative act that was contextually sensitive, dialogic, and cocreated in the collective efforts of groups of people, very much in agreement with the constructivist reasoning of educational philosophers like Lev Vygotsky (Glaveanu, 2011, pp. 480–481). This "We paradigm" of creativity proposed an integrative account of creative behavior, most especially in emphasizing the mediational role of cultural artifacts—psychologically profound physical and conceptual creative products—through which societies expressed and accumulated their experiences over time (Glaveanu, 2010, pp. 84–86).

Glaveanu's insight concerning the nature and significance of the cultural mediation of conceptual artifacts encourages a divergent perspective with regard to interpreting the evidence provided by Granic et al. (2014). The shift involves understanding the social and motivational benefits of video game interactions and their contribution to creativity, as a positive influence transmitted throughout a social group. This invokes, too, the notion of how developments in the application of sociocultural theory can inform the practical realities of employing video games in the educational context—"gamifying" learning (Deterding et al., 2011)—as a medium for meaningful influence on the creativity of young people. For, as Glaveanu (2010) elucidated, constructivist theories and sociocultural formulations have already been well represented in the study of certain topics in the learning sciences. As Jackson et al. (2012) and Bowman et al. (2015) demonstrated, there is already a willingness to make use of educational gaming platforms as a tool for enhancing creativity.

First, though, to make any use of the idea of Glaveanu's (2010) mediational tools as a means to analyze the social aspect of the creative benefit of video gaming, there is a need to demystify the construct. Egan (1997) offered one thoughtful method of doing so: That the essence of games, narrative, and the imagination, the tropes that undergird how individuals come to understand wonder in the world, are, in themselves, these mediational tools (1997, pg. 5). Derived from stages of development and the internalization of cultural literacy, Egan (1997) conceptualized a number of these "cognitive tools" of the imagination—binary structures, fantasies, heroes, extremes of reality, collections, anthropomorphism, and curious anomalies, to name a few—and ordered them in a sequence, progressing from basic somatic understanding, through mythic and romantic understanding, to a sophisticated theoretical or ironic understanding of the world. In this way, as Egan (1997) posited, mediational tools become simultaneously the products of the individual imagination and cultural mediators of learning, as recapitulations following the story form embedding a "cognitive tool" are thought to be facilitative of salient integration of conceptual knowledge.

Following Egan's (1997) interpretation, then, mediational tools bind up the social and creative influences of video games into a reciprocal relationship, generating an additional layer of explanatory power to texture the social benefits of video gaming to the creativity of social groups. Take, for example, Jackson and Games's (2015) analysis of the social role of the different genres of video games, wherein they struggled to explain the seeming paradox of violent video gaming as a positive influence to the prosocial behavior of young people, coming only to the conclusion that the collaborative quality of play would mitigate the negative effect of the violence (2015, pp. 23): Through the lens of mediational tools as they are used in video games, the effect would not be paradoxical at all; it would instead be considered the reasonable result of an act of collaborative creativity through which positive effects from violent video games would be an expected outcome of socially experiencing an archetypal "extreme of reality" (as in Egan, 1997, pp. 83–84). Thus, in this instance, the social benefit of gaming would not be in collaboration alone, but, would be, more finely conceptualized as an exemplar of interaction mediated by a known type of cultural learning tool.

As Egan (2005) argued, the real utility of mediational tools is to be found in applications that drive learning and motivation, particularly in educational environments. In line with this reasoning, Egan (2005) organized an instructional theory, the *Imaginative Education* method, based around incorporating these tools into classroom practice, and further exemplifying throughout his work the process of recapitulating components of knowledge through the captivating medium of mediational tools such that they might better engage the sense of wonder in the imaginations of learners and enjoin deep, creative thinking.

Taken into the purview of collaborative creativity, motivation is a topic with a great deal of conceptual interrelation to the social and creative benefits of video gaming. Sociocultural theory includes the concept of the "zone of proximal development" (ZPD), that "sweet spot" between challenge and frustration that contributes to the motivational benefits of long-term experience with video games (Granic et al., 2014, pp. 65–66). Thus well-crafted video games might occupy a central conceptual location of the ZPD in being just challenging enough to enjoy and motivate through continual engagement of those conceptual elements which were distant prior to the experience.

This idea finds resonance across scholarship relating video gaming, creativity, and the sociocultural perspective because an appeal to the effect of maintaining engagement in the ZPD can be seen in works describing the mechanism by which the creative benefits of collaborative creativity are to be understood (Glaveanu, 2011, pg. 48), and also, more precisely, in accounts in which the creative benefits of video gaming are conferred to individuals and groups of players (Jackson and Games, 2015, pp. 26–27). Indeed, so central to the notion of collaborative creativity was the topic of motivation that Glaveanu (2011) promoted it as part of the "new vocabulary" to understand creative behavior, one that was organized around the study of (1) ongoing interactions occurring via mediated contact, (2) the dimensions of socioemotional, motivational, and identity relative to creativity, and (3) the macrogenetic (socially and developmentally structured) aspects that influence daily creativity (2011, pg. 481).

In synthesis, Glaveanu's (2010, 2011) sociocultural theory of collaborative creativity enriches an understanding of the socially creative benefit of video gaming through the construct of mediational tools and, at the same time, situates the motivationally creative benefit of video gaming in the larger structure referencing the optimally challenging conditions occurring within the zone of proximal development. Here, Egan's (1997, 2005) work represents an instantiation of the sociocultural theoretical perspective, serving to unpack the historical, social, and developmental meanings of mediational tools, granting clarity in their constitution, and also in the prescriptive application of those mediational tools in learning environments as an effort to capitalize on their capacity to increase motivation by evoking wonder. This, by extension, would ameliorate difficulties with inert knowledge in the learning environment, modulating the challenge of deep conceptual learning. Evidence from both Granic et al. (2014) and Jackson and Games (2015) supports this sociocultural interpretation, both in articulating the social and motivational benefits of video gaming.

Future research guided by this theoretical framework might adopt an integrative approach to determining the culturally creative benefits of video gaming by examining the effect of mediational tools on the motivation of social groups. In a gamified learning setting, this might take the form of an educational video game with features drawn from the mediational and pedagogical tools of imaginative education. Assessment of outcomes could follow a mixed-methods approach, making use of participant interviews about creativity in the group, as well as self-report measures of creative engagement, response to creative environment, and intrinsic motivation. Alternatively, and more simply, a researcher might choose to investigate the effect of utilizing a single mediational tool on the creativity of a social group or organization, tracing, for example, how a creative group might structure binary opposites as they work through a problem together, or how, in constructing an audience, the group draws on experiences of extremes of reality. Such a study could be ethnographic in nature, entailing inquiry posed throughout the full arc of a creative endeavor, or it could be quantitative, contrasting influences across many social groups.

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Technology: Memes (Units of Culture)

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Glossary

Applied Evolutionary Epistemology The study of the units, levels, processes, and mechanisms by which (1) biological, (2) cultural, and (3) biocultural evolution occurs. See also (Gontier, 2012).

Archive The units of culture (ideas, processes, products; memes) *not* selected as canon, in a domain in culture. The equivalent (in biology) of dead or extinct lifeforms, or fossils. Over time, archived memes may become canon, just as extinct lifeforms can be recreated. Conversely, canonical memes can go archive over time.

Biological Evolution The operation of the evolutionary algorithm, resulting in units in biology surviving (the currently living units being ‘canon’), or, going extinct (thus becoming ‘archive’/fossils).

Canon Units of culture (ideas, processes, products) that are selected by the field, and are thus populous (or “viral”) in bioculture. The equivalent of living, surviving units in biology. Canonical artifacts exist as (external) *e-memes* in a domain, and as (internal) *i-memes* in the minds of those in the field. Canon is the complement of ‘archive’ in a domain.

Creative The standard bipartite definition of *creative* is a cultural artifact (a meme: an idea, process or product) that is judged *original and effective* (Runco and Jaeger, 2012), or *new and useful* by consensus of a field of experts for a domain in culture. The tripartite definition of creative is an artifact that is *new, useful, and surprising* (Simonton, 2012). See also (Kozbelt et al., 2010).

Cultural Capital Knowledge, information, skills, taste, and expertise possessed by an individual or group.

Cultural Evolution The process by which evolutionary algorithms (*macro*: variation, selection, transmission, and also, *micro*: selection, variation, transmission) results in units of culture (memes: ideas, processes or products) becoming canon or archive over time.

Culture Culture is composed of *domains of knowledge* (the sciences, social sciences, the arts/humanities/communication; also cuisine, clothing, transportation, education, architecture, etc.), and *domains* are composed of memes (units of culture, i.e., units of information). These include: ideas, processes, products. *Ideas* can include concepts, principles, beliefs, models, theories.

Processes include customs, traditions, social behaviors, algorithms. *Products* include words, sentences, languages, numbers, symbol systems, images, photographs, idioms, catchphrases, artworks, buildings, inventions, and any tangible cultural artifact.

Economic Capital Refers to ownership of—or access to—financial resources, or property, including intellectual property.

Evolutionary Algorithms A process such as Selection, then Variation, then Transmission of a unit. A process whereby units are (1) *selected* from a pool, then (2) *varied* (by combining parts of two or more existing units), and then (3) *transmitted* back into the “pool” or population of competing units in an environment, where natural, and/or artificial (intentional), sexual, or unconscious selection also operates, and deletes the less-well-adapted units. The gene pool in biology (in DNA) is analogous to the meme pool (ideas, processes, products) in culture; evolutionary algorithms operate on both pools, on different scales and levels.

Evolutionary Epistemology The study of how knowledge in cultural domains (scientific, artistic, technological) evolves via selection.

Habitus As described by Pierre Bourdieu, ‘a feel for the game’ developed over a lifetime of immersion in domains and fields. A *habitus* is shared (in fact, learned) among people of similar profession, ethnicity, nationality, education, social class, and religion (Bourdieu and Johnson, 1993).

Holon/Partons Parts which are also a whole. Systems are holon/partons, being composed of (smaller) holon/partons. These are governed by the three laws of holon/partons, in addition to any other laws, rules, codes, or forces which may also be acting upon them, such as the current disciplinary zeitgeist of the field for a domain in culture.

I-memes Mentally-stored information (internal culture), namely the units in a person’s memory that were once e-memes (external memes), that they have learned, internalized or otherwise mentally absorbed. Biological instincts are not considered i-memes on this view of culture, as instincts are algorithms hard-wired into the organism via DNA and epigenetics.

Internet Meme An (often humorous, or ironic) image with text-caption shared on social media, or videos and other media shared on the internet. Internet Memes are a very small subset of all cultural memes; namely, of all ideas, processes, and products.

Kuhnian pre-paradigm state The state that a field and domain is in, before the scientific units (fundamental particles), criteria, and key problems are determined for a domain of study; see Thomas Kuhn (1996).

Memes Units of culture: ideas, processes, products. These are structured as holon/partons. Memes are either internal, mental representations (i-memes) or external physical culture (e-memes).

Memeplexes Complex memes. The term is relative, because an idea such as ‘computers’, or ‘the universe and every thing in it’ can contain many complex ideas. A transmedia story is a memeplex, as is a religion, or even a Kuhnian scientific paradigm. A memeplex is also a holon/parton, a unit of culture, a meme.

Multilevel Selection Theory The scientific theory that selection (natural, artificial/intentional, sexual, unconscious) in evolutionary processes operates at the various units and levels of the biological holon/parton: genes, DNA, cells, organisms, groups, species, biospheres. MLS also applies to culture on the various units and levels of the holon/parton: letters, words, sentences, books; and scientific, literary, musical, and cinematic canon.

Problems Defined here in the broadest sense, as: wants, needs, desires, goals, tasks, or objectives. Problems can also include obstacles to these goals. Examples of problems include: surviving, reproducing (raising offspring), staying healthy and happy, and avoiding illness, injury, undesirable stress or boredom, and more.

Selection pressure Where units effectively compete with each other for finite resources (e.g. food, or human attention) in any environment, pressure causes some units to adapt (or they are adapted by intentional re-designers) and thrive, while others are forced out of the ecological niche and may go extinct, unless they become adapted (or are exapted) to another niche.

Social Capital Social networks, relationships or connections, or “who you know” within a field for a cultural domain.

Symbolic Capital Awards, or recognition such as senior guild memberships and honorary titles.

Technology Anything that is a *tool*—from a rock used as a hand-axe, to a computer mouse, or car; from a word or a language to a diagram or book; from a computer to an fMRI machine. All units in culture (ideas, processes, products; memes) are problem-solving (goal-attaining) tools, and thus are bio-cultural technology.

Memes: Tools/Technology/Culture

Memes are units of culture. They generally take one of three forms: ideas, processes, or products. Memes are technology, as they are tools used for solving problems. The word “problems” is here used in the positive sense of the term, namely goals, tasks, aims, objectives, urges, wants, needs, desires. Sub-problems also can include any obstacles to such goals.

Memes are the key subject-matter that scholars generally examine in scientific studies, including the study of creativity. Once a cultural product—such as a scientific model, an artwork, book, song, or invention—is judged by consensus of the field to be creative (i.e., original and effective), creativity scholars can investigate the processes or the events that caused the emergence of that creative cultural artifact.

Culture as Solutions to Problems

All memes (units of culture) are solutions. Some solutions are judged by the field as more original and effective than others. As an example, the mental model or (1) *idea* of Einstein's $e=mc^2$ equation meant that (2) a *process* of converting matter to energy could be predicted and controlled, and eventually resulted in (3) the *product* of the atomic bomb. Although nuclear weapons created new problems, in 1945 they ended World War II, saving millions of lives. Creativity also raises the question of values and ethics, since with life comes problems, and the values placed on resources by individuals and groups. Any technology may be used for good or for evil.

All domains in all cultures of the world are composed of memes. They are solutions informed by values. This problem-solution view of all culture is illustrated via selected examples in [Table 1](#).

Units of culture include (but are not limited to): numerals; letters of an alphabet; symbol systems; words; phrases; languages; scientific or mathematical formulae; cultural customs, traits, rituals, practices, behaviors, beliefs, concepts; games; jokes; poems; paintings; songs; dances; novels; nonfiction books; scientific models; newspapers; technological and architectural blueprints or maps; legal systems; construction tools; buildings; books; movies; television shows; videogames; comics; clothing styles; cooking recipes; foodstuffs; measuring instruments; white goods; vehicles; aircraft; weapons; fuels; urban myths; conspiracy theories;

Table 1 Some units of culture (memes: ideas, processes, products) as problem-solutions.

<i>Problem</i>	<i>Solution: The idea of</i>	<i>Solution: The process of</i>	<i>Solution: Products, such as:</i>
The desire to communicate (interact) verbally and aurally	Verbal utterances conveying meaning (communication)	Speaking; listening; using grammar and syntax, having a conversation, etiquette	Communication tools: Words, grammar, syntax, sentences, speeches, conversations, landline telephones, smartphones, video calls, the internet
The desire for written communication or interaction	Stored symbolic information (written symbols)	Writing, drawing, using a computer to transmit symbols	Written words, languages, diagrams, clay tablets, codexes, printing press, books, emails, web pages
The desire for expressive, aesthetic, and/or moral communication or interaction	Art forms, fiction storytelling, songs	Drawing, painting, sculpting, creating fiction, making: movies, novels, songs, dances, television shows, etc.	Drawings, paintings, sculptures, movies, novels, songs, dances, television shows
The desire to eat	Culinary arts	Cooking, making and using recipes	Recipes, meals, plates and cutlery, ovens, refrigerators, kitchens, cafes, restaurants, etc.
The desire for attack or defense	Weapons and shields	Weapon making, weapons training and practice	Clubs, spears, axes, shields, martial arts, guns, missiles, tanks, aircraft, bombs, armies
The desire for bodily protection from the weather or elements	Clothing	Designing and making clothing	Coats, shoes, pants, shirts, dresses, hats, clothes stores & factories, clothing fashion styles
The desire for travel (across: Land, water, air, space)	Transport, via animals or vehicles	Designing and making vehicles, repairing vehicles, taking journeys in vehicles	Vehicles: carts, bicycles, cars, trucks, buses, tanks, boats, submarines, trains, aircraft, spacecraft; fuels (petroleum, electric, solar); auto repair shops
The desire to understand, predict and control: Health	Medical science	Diagnosis and treatment of illness; medical drug tests; diets; exercise	Medicines, drugs, vaccines, diets, surgeries, surgical tools, hospitals, medical textbooks, gyms, educational courses
The desire to be informed, entertained, and/or educated	News, gossip, entertainment, education	Creating and consuming: news, gossip, entertainment, education	Newspapers, TV, radio and internet news programs, books, videogames, documentaries, etc.
The desire for sexual pleasure, fornication	Sexual intercourse, masturbation	Courtship, dating, sexual fantasies	Sex, contraceptive devices, pornography, prostitution, erotica, etc.
The desire to understand, predict and control: Energy, matter, information	Physics (as one example)	Physics experiments; Planned (controlled, predicted) subatomic particle collisions	The double-slit experiment; the large Hadron Collider; nuclear power plants, etc.
The desire to go to the moon	Space exploration/discovery	The Apollo space program	Computer microchips, spacecraft, spacesuits, freeze-dried food

religions; worldviews; Capitalism; Marxism; Freudianism; Darwinism; and machines such as the printing press, electronic computers, 3D printers, the internet, and the Large Hadron Collider. All are problem-solving tools, thus all are technology. All are memes.

Problems (i.e., Goals) Emerge From Life

As Sir Karl Popper (1999) and Brian Boyd (2009) have noted, problems emerge with life, and all life is problem solving. Problems can also be categorized using the six levels of Abraham Maslow's (1969) hierarchy of human needs (goals, problems). These can range from staying alive, healthy, and happy for as long as possible, to achieving self-selected goals of creative mastery of a domain in culture. Maslow's sixth level is "transcendence", via advancing a cause larger than oneself in any domain, and enjoying "peak experiences" or what Csikszentmihalyi (1990, 1996) termed the "flow" state.

Biological systems such as plants and animals modify, fill, and construct ecological niches. Like nature, culture abhors a vacuum; so creative people frequently find better solutions. As solutions, inanimate units of culture (memes) can fill, construct new, and also alter, cultural ecological niches. Entertainment media such as television, videogames, movies and music can also place their audiences in the flow state. Sometimes they contribute to the growth of the Creative Industries.

New problems can also be caused by advances in memes (technology): improved medical science has caused a human population explosion, while fossil fuels and overconsumption have accelerated global climate change. In turn such problems require new creative solutions, in an iterative spiral of cultural evolution.

Getzels (1982) showed that unsolved problems in a domain in culture are of three main types: "presented", where the field is aware of the unsolved problem; "discovered", where a creative person identifies a hidden problem; and "created", where the problem (or goal) is newly formulated by an individual or group.

A Brief History of the Domain of Memetics/Cultural Evolution

As with the domain of Biology prior to Watson and Crick's (1953) discovery of the structure of DNA, the domain of Memetics—as a science of cultural evolution—was in a Kuhnian pre-paradigm state prior to 2016, as the hard domain problems of the unit, the structure, and criterion of the meme remained unsolved.

Charles Darwin and Richard Dawkins made important discoveries in both biological and cultural evolution. Darwin (1871) observed that individual units of culture (words, and languages) evolve via natural selection, including their historical spread and extinction. The prospect of a true Science of Cultural Evolution was raised when Richard Dawkins' (1976) popular science book *The Selfish Gene* noted that units in culture evolve. Dawkins coined the term "meme" for units of culture, or:

"a unit of cultural transmission... Examples of memes are tunes, ideas, catch-phrases, clothes fashions, ways of making pots or of building arches... If a scientist hears, or reads about, a good idea, he passes it on to his colleagues and students. He mentions it in his articles and his lectures. If the idea catches on, it can be said to propagate itself, spreading from brain to brain" (Dawkins, 1976, p. 192).

Dawkins is here describing the spread of creative (i.e., new and useful) ideas, processes, and products. This transmission of units of culture (memes) in society can be viewed via Lasswell's (1948) 5-W model of communication (see Table 2).

Table 2 Lasswell's 5-W model of communication.

Question (Lasswell's 5 W's)	Element	Analyses
Who	The <i>creator (and/or) transmitter</i> of the message or information (i.e., the meme, or unit of culture)	Creativity studies; media ownership and control studies; Communication studies
Says What	The discrete transmitted <i>meme</i> /information/problem-solution (idea, process, product)	Creativity studies; comparative form, content, and (semantic and pragmatic) meaning analysis of the specific transmitted unit of culture
In Which Channel	The <i>Medium</i> (audio, visual, verbal, written text, film, television, book, academic journal, email, social media, painting, sculpture, invention, and so on)	Creativity studies; Media studies; Communication studies; Information Science and Technology; Arts/Humanities
To Whom	The unit's (the meme's) <i>receiver; the audience; the field</i> for a domain	Creativity studies; Audience studies; demographics
With What effect?	The <i>effect(s)</i> of the specific problem-solution (specific discrete meme, or unit of culture)	Creativity studies - is the unit then widely re-transmitted as canon, or ignored as archive? Why, or why not? Effects studies - how does the meme affect the behavior/experience of the recipient(s)?

Adapted from Lasswell, H., 1948. The structure and function of communication in society. In: The Communication of Ideas, Institute for Religious and Social Studies, New York, pp. 117–129.

Following Dawkins (1976), much was written on the nature of memes (see Memetics Bibliographies in *Relevant Websites*), with alternate terms coined as synonyms for “meme” including: “culturgen” (Wilson and Lumsden, 1981), “tème”/“treme” (Blackmore, 1999), “mneme” (Semon, 1921), “seme” (Buysens, 1943), “deme” (Situngkir, 2004), and “mind virus” (Dawkins 1991). From 1997 the *Journal of Memetics* was published but ceased in 2005 under criticisms that the field of Memetics had not yet scientifically identified the unit of culture, nor solved the measurement, criterion, or theoretical model problems. In 2008 a five-year study of Memetics commissioned by the US military’s DARPA (Defense Advanced Research Projects Agency) resulted in a 1680-page report reviewing the extant knowledge on memes, but did not scientifically identify or accurately define the unit of culture (see Finkelstein, 2008). DARPA’s aim with Military Memetics was to fight wars and terrorism at the level of ideas (what we can now view as Sir Karl Popper’s (1978) “World Three”) and mental processes (or Popper’s “World Two”) rather than in the external physical realm of bodies, bullets, bombs, and blood (Popper’s “World One”). A parallel body of research also exists on Cultural Evolution that is not published under the rubric of Memetics; Creanza et al. (2017) contains an overview.

A Solution to the Meme Puzzle

In a 2016 Ph.D. study, communication scholar J. T. Velikovsky proposed a solution to the structure and mechanisms of the unit of culture. Once the unit, criterion, and measurement problems of culture are resolved (via Systems Theory) the controversy around memes dissipates. The remainder of this article summarizes this new view of the meme, (the unit of culture), and *Creative Practice Theory* (Velikovsky 2016a,b), a twelve-stage algorithmic model of cultural evolution, synthesizing evolutionary systems models of culture by Darwin, Csikszentmihalyi, Gruber, Simonton, Bourdieu, Koestler, and Popper.

The Systems Worldview

Mihaly Csikszentmihalyi (1988) and Howard Gruber (1988) both called for and defined systems views of creativity. A landmark article on creativity by Hennessey and Amabile (2010) in *Annual Review of Psychology* also called for the Systems View—from culture, down through six major systems levels, to the neurological—to further illuminate the phenomenon of creativity.

Stated most simply, a system is a “black box” with algorithms (processors) inside it; has inputs and outputs; and the system is located in an environment, or biocultural ecosystem (Fig. 1).

Systems are made of energy, information and matter. *Natural*, organic, living systems (plants, animals, whole ecosystems) have different inputs and outputs to *artificial*, human-made, manufactured systems (machines, factories, vehicles, transportation systems, towns, cities). A beaver’s lodge and dam, ant’s nest, bee’s hive, spider’s web, and crows’ and chimps’ use of tools are natural technological artifacts; niche construction; or “natural” culture.

Systems also contain algorithms for processing or converting inputs into outputs, and to monitor, grow, and maintain the system. As biological systems, organisms are algorithms, being information, energy, and matter processors. Complex systems are composed of smaller systems, and are part of larger systems. Fig. 2 is a Systems View, from quarks to the multiverse.

Theoretical physicist David Bohm (1980) suggested that the scale of these units continues infinitely smaller (“downwards”) and larger (“upwards”).

If we begin with the “Person” system (center of Fig. 2), we see they are composed of smaller systems/units (including: 11 organ systems; 79 organs; 10^{14} cells; and so on). The person is also a part of larger systems and ecosystems (a local community; a legal state or province; one of 195 current world nations; a biosphere; a solar system; a galaxy; and so on). Each system on each level (as indicated in the diagram) is a holon/parton.

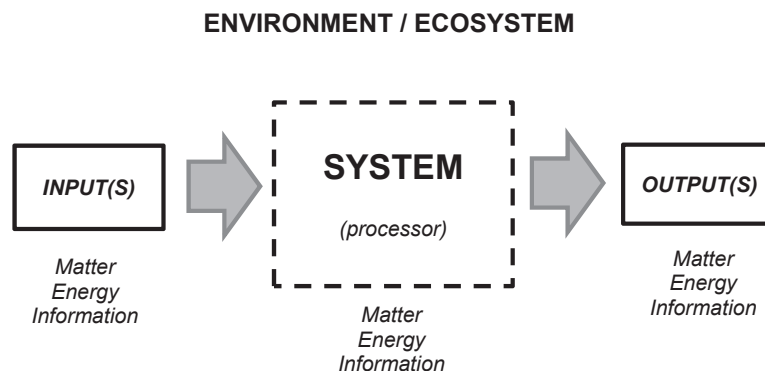


Figure 1 A system in an environment.

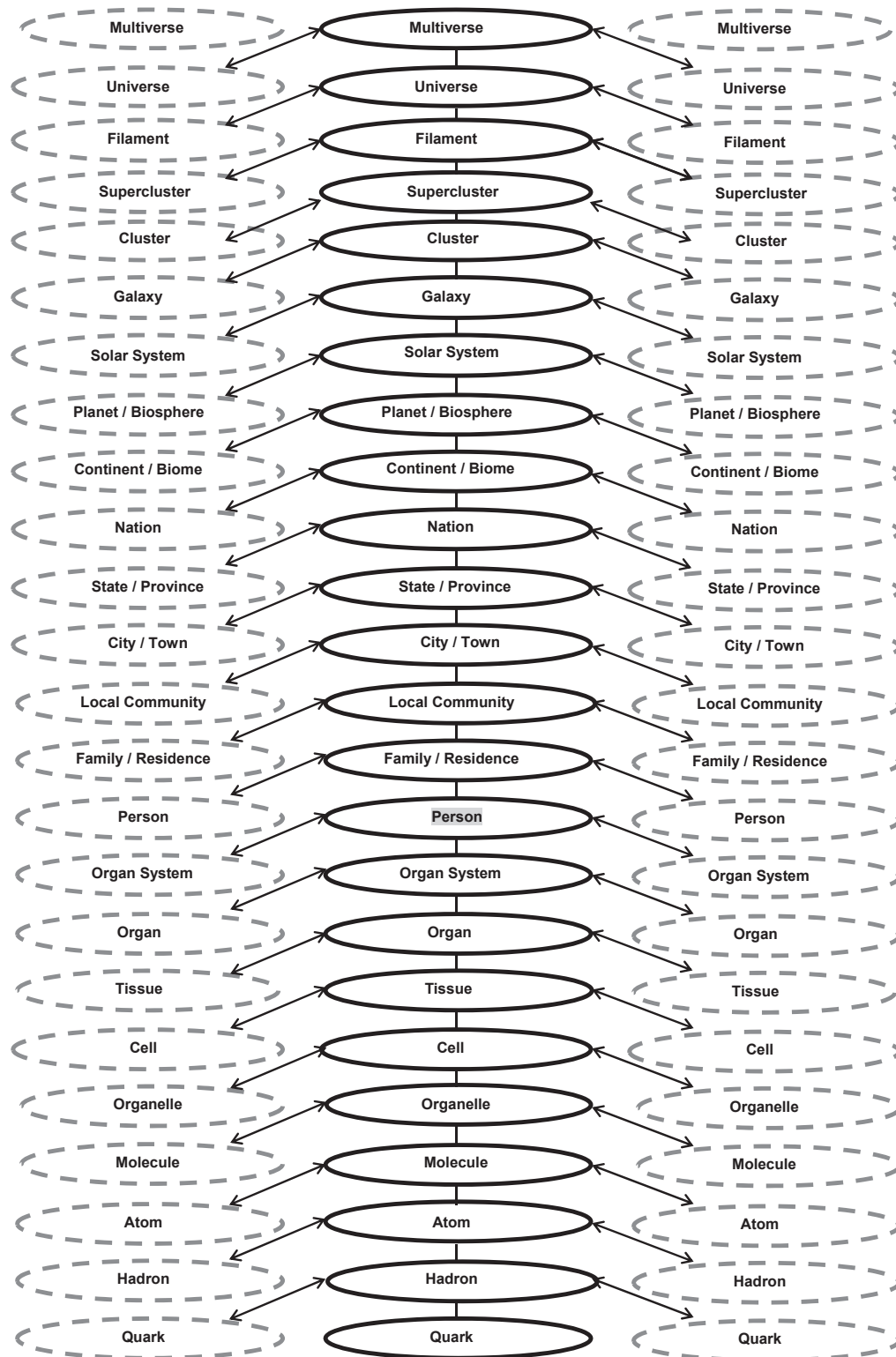


Figure 2 A systems view, from quark to multiverse. Adapted from Velikovskiy, J.T., 2016a. The holon/parton theory of the unit of culture (or the meme, and narreme) in science, media, entertainment and the arts. In: Connor, A., Marks, S. (Eds.), *Creative Technologies for Multidisciplinary Applications*, IGI Global, New York, p. 211.

Systems as Holon/Partons

A holon/parton is a whole unit, that is also a part of a larger unit. It is a whole and a part at the same time. The three laws of holon/partons—which are also laws of physics—are that they each:

1. Compete, and/or co-operate (collaborate) with other units on the same level; and
2. Control and command the units on the level “below”; and
3. Integrate into the larger system on the level “above”, of which they are a part.

On this view, humans are emergent physico-chemico-bio-psycho-socio-cultural systems. In Systems Theory, Systems (and Complexity) Science, Systems Philosophy and Systems Thinking, the concept of “emergence” means that the properties of the whole unit cannot merely be explained by the sum of its parts. Consilience, the vertical integration of the sciences, also illustrates this concept of *emergence* (see Fig. 3).

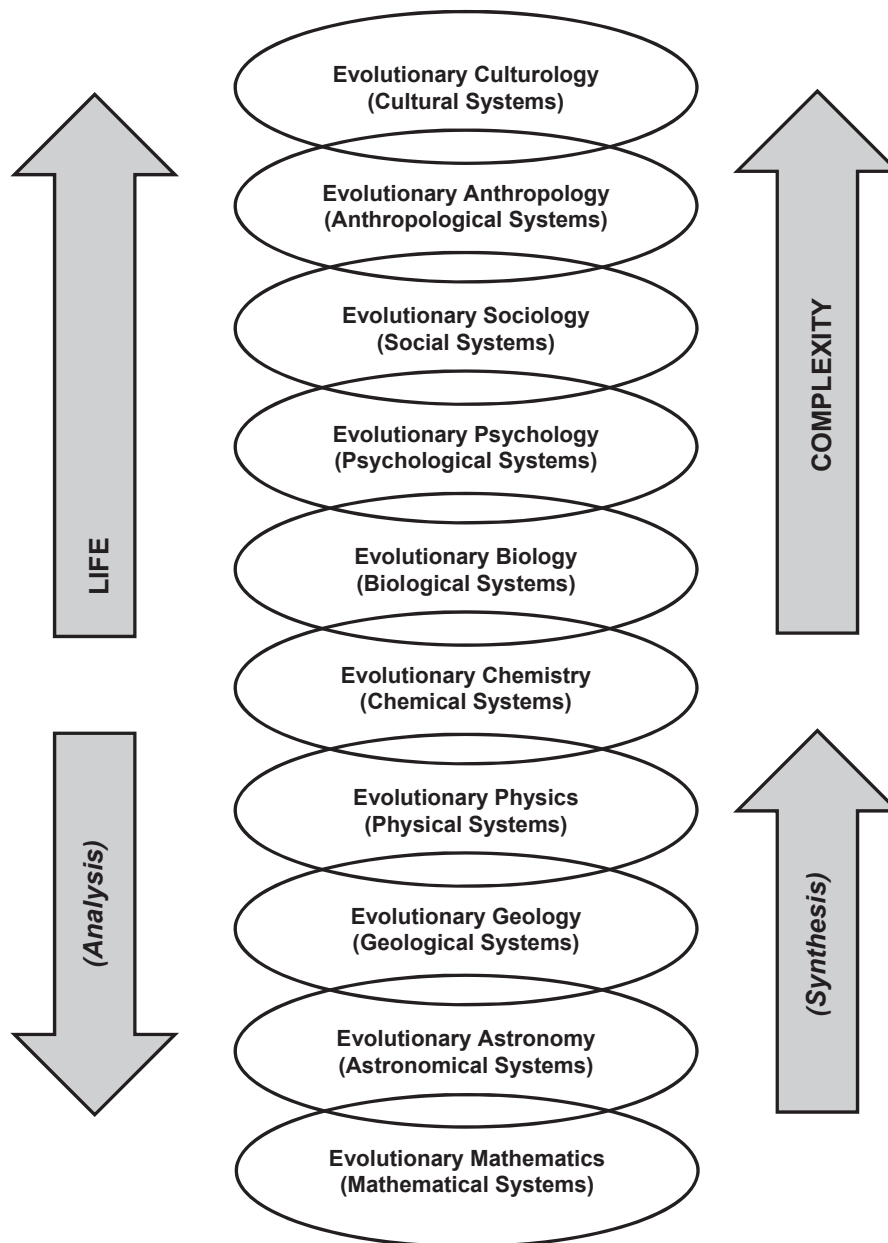


Figure 3 Consilience: The vertical integration of the sciences, or the unity of knowledge.

Emergence

Once stars and planets exist (physical and chemical artifacts in the domain of Astronomy), and also Physics, Chemistry, and Geology (including their systems-laws governing water, land, and an atmosphere on a stable planet), single-celled and multi-cellular life (organic chemistry) and a biosphere may emerge over deep time, as it did on Earth 3.5 billion years ago. In individual self-replicating lifeforms an Evolutionary Psychology emerges aimed at survival and reproduction, namely “IF/THEN/ELSE” decision-algorithms such as instincts, behaviors, cognition, and a spectrum of consciousness. Groups of social lifeforms enable Social Systems (thus an Evolutionary Sociology) to emerge. Societies develop Evolutionary Cultures, a set of problem-solutions that are either selectively retained as canon, or discarded as archive. The canonical units (memes) are transmitted “horizontally” to others socially, and also “vertically” across generational lifespans via communication media (recorded language, writing, books, films, and so on).

In physical terms, an evolutionary algorithm (Variation, Selection, Transmission) operates on the units within each domain, and also on the cultural knowledge about each domain, via “Domain, Person, Field, interaction” (DPFi) systems (Csikszentmihalyi, 1988, 2014), while in the newly-emergent “Creativity 4.0” (Csikszentmihalyi and Gruner, 2018), Artificial Intelligence also enters into the DPFi systems model. On micro levels, the peer review of academic journal articles for a domain in culture is one example of a DPFi system, with peer reviewers and editors acting as “gatekeepers” to the canon of that journal. The emergent domain of the scientific study of units of culture (memes: ideas, processes, products) is Evolutionary Culturology. In Fig. 3, Mathematics underpins all these domains due to the striking efficacy of mathematics and complex systems theory in the natural sciences (Wigner, 1960; von Bertalanffy 1968), and also due to the high probability that we are living in a simulation of a multiverse (see Bostrom, 2003).

Using these conceptual tools of holon/partons and Systems Thinking, we now turn to the units of culture.

The Holon/Parton Structure of the Meme, the Unit of Culture

Velikovsky’s Ph.D. appendix (2016b) included the following model. This discovery allows for scientific analysis and comparison of the discrete units, levels, mechanisms and processes of selection in culture via methods in Applied Evolutionary Epistemology, the Digital Humanities, and related disciplines. A diagrammatic analogue of holon/partons appears in Fig. 4.

Holon/partons are fractal (self-similar in structure) when viewed on different scales. An analysis of some written text—as holon/partons—appears in Fig. 5.

Just as quarks-to-multiverses can be seen as holon/partons governed by three laws of physics, units of culture are also governed by these same three laws of holon/partons. The units and levels of “external” culture (or “e-memes”) can be distinguished, centering on a unit (a book) in the cultural domain of canonical books (see Fig. 6), be it a novel or a nonfiction book (e.g., *Don Quixote*, *To The Lighthouse*, *On the Origin of Species*, *The Selfish Gene*, and so on).

Each of these units of culture—on each level (in Fig. 6)—are holon/partons. Each unit obeys the same three laws: they (1) compete, and/or co-operate “sideways” with other units on the same level; (2) control and command “downwards” the units on the level below; and (3) integrate “upwards” into the larger unit above. This is to note that any canonical book competes for human attention with other extant canonical books within its literary genre; with all other canonical books in a culture; and with all other communication media in culture (e.g., television, films, games, the internet, electronic social media and so on). Moreover in composing a book, a writer must select a single word at a time from among all its competing synonyms. On levels “above” the word, authors also rewrite sentences from competing alternative sentence structures (oftentimes under an editor’s direction, using selective retention). While a unifying concept (or idea) underpins any single book, the additional laws (codes, rules) that determine each unit also change, as the levels change. Namely, the laws governing sentence structure (see Pinker, 2014) differ from the laws, rules or codes determining a (coherent, canonical) book’s chapter organization; and those are not the same rules as those governing a literary canon, or a genre, or library corpus selection. Yet all the component units, on all levels, behave as holon/partons according to the three laws of physics. E. O. Wilson (1998, p. 291) suggested that laws of physics might apply to culture, and on this view it indeed appears to be the case.

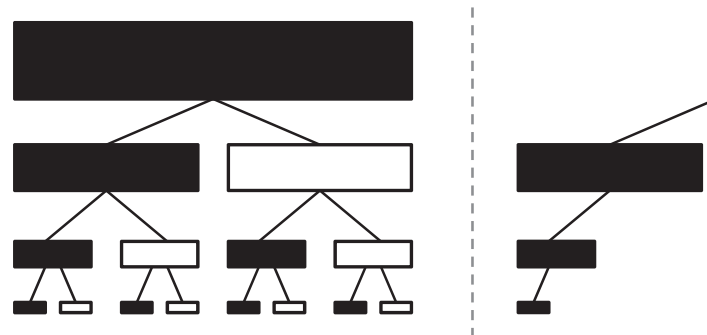


Figure 4 A Cantor Set, showing the structure of a holon/parton. Single units on each level are shown on the right.

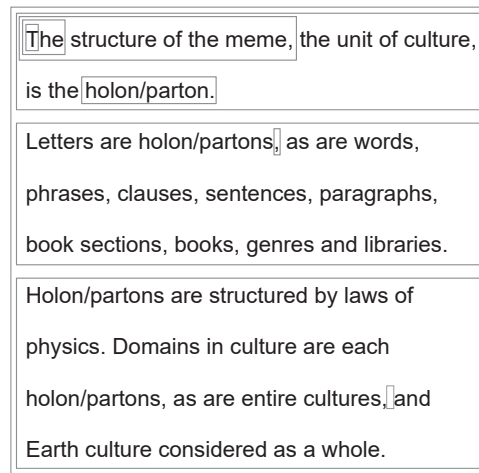


Figure 5 The holon/parton structure of units of culture applied to some written text. Adapted from Velikovsky, J.T., 2016a. The holon/parton theory of the unit of culture (or the meme, and narreme) in science, media, entertainment and the arts. In: Connor, A., Marks, S. (Eds.), *Creative Technologies for Multidisciplinary Applications*, IGI Global, New York, p. 220.

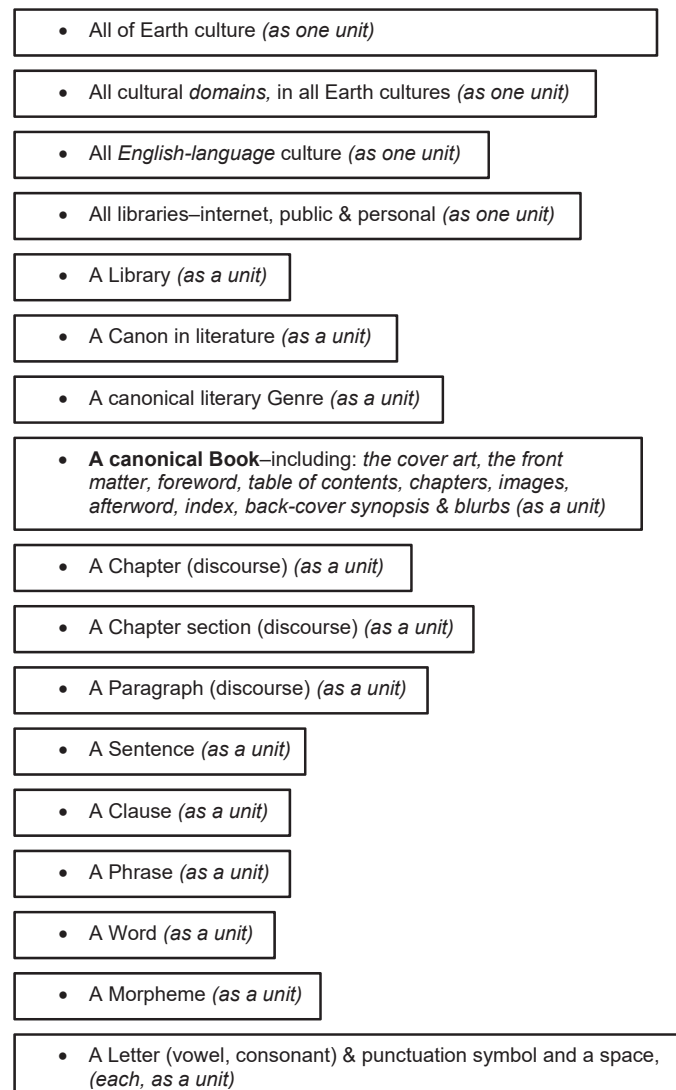


Figure 6 Units of culture in a canonical book. Each unit on each level is a holon/parton.

Using the same holon/parton Systems View, the units and levels of selection in other domains (or “species”) of culture can be identified, including in movies, games, plays, songs, poems, jokes, spoken language, science, art, and religion (see Velikovsky, 2016a, 2017a, 2018a, 2019). The discovery of this scientific model—the holon/parton structure of the meme, the unit of culture—may apply universally across all canonical cultural domains, and can be tested in non-English languages and cultures (even in the atypical Pirahã culture) with the aim of Popperian falsification.

E-Memes and I-Memes

The information stored in this encyclopedia is an external unit of culture (an e-meme) until a reader internalizes it, by perceiving and comprehending it; it then becomes an internal unit of culture (an “i-meme”), stored in their short-term memory.

External units of culture (e-memes) are ideas, processes and products manifested outside the human mind as physical cultural artifacts in the world (Popper’s “World One”). Examples include ideas—or algorithms (processes)—that have been written down or otherwise recorded (a cooking recipe, scientific theory or method, computer program, architectural blueprint, movie screenplay, sheet music and lyrics, religious text); also construction tools (hammer, nail, saw, forklift, crane) and other human-made artifacts (vehicles, bridges, buildings). A song played on the radio, a movie exhibited in a cinema, and a verbal conversation are all e-memes. When humans absorb and remember a specific e-meme—or segments thereof—it becomes an i-meme in their minds (see Fig. 7).

Parts (or wholes) of e-memes in the external world can become i-memes in a mind, such as a catchy chorus from a song; a memorable line of dialogue from a person, famous historical figure, play, movie or television show (see “100 Best Movie Quotes” in *Relevant Websites*); a creative scientific theory (such as $E=mc^2$); or a joke; and may be transmitted in the infosphere (the “e-meme pool”) via word of mouth, written form, or any communication media. The well-adapted (i.e., creative or “favored”) problem-solutions in culture are transmitted among the field (the audience, or consumers in a domain) and become canon, while the less well-adapted (uncreative) ones recede in the frequency of their occurrence and become archive.

The organic environmental niches for i-memes are human minds; currently these number around 7.6 billion on Earth. The English language (or parts thereof) is an i-meme in approximately 1.5 billion of these human minds, and also exists as e-memes stored in physical dictionaries, in English language course materials, on the internet, and in other communication media. I-memes are thus *learned* units of culture (ideas, or processes, or products) stored in a person’s memory, inside a human brain or nervous system.

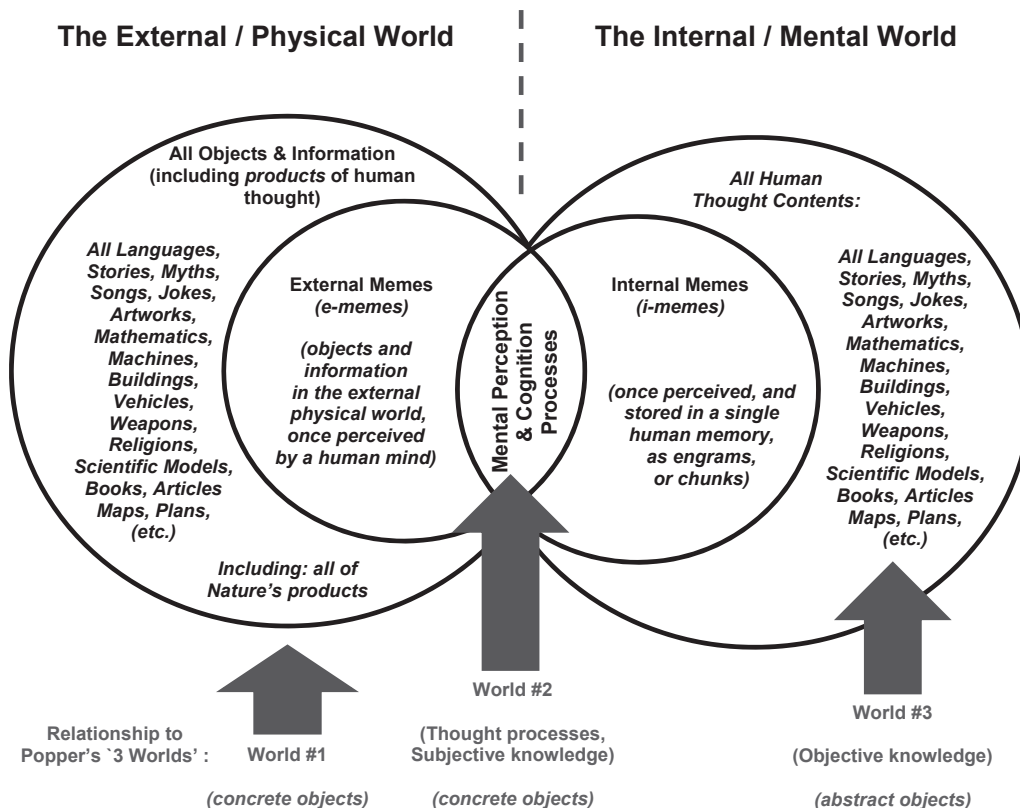


Figure 7 E-memes and I-memes, and their relationship to Popper’s “Three Worlds”. In Figure 7, the two overlapping (inner) circles represent an individual person’s awareness of specific e-memes, and of i-memes already stored in their memory. The two larger (outer) circles represent all external (e-meme) units of culture, and all internal (i-meme) units of culture that exist.

Measurement of Memes (as E-Memes and I-Memes)

Cognitive science currently measures the new units added to a human's short term memory as "chunks" (Miller, 1956) or as engrams, while external information (as e-memes) are usually measured in Shannon and Weaver's (1949) "bits" (binary digits) and bytes. The size of the newly-stored chunk or engram for an i-meme in each individual human instance depends on many variables including: (a) what the person already knows; (b) Bayesian learning (updating one's worldview based on new data); and (c) Kullback-Leibler divergence (a mathematical measure of surprise). As functional Magnetic Resonance Imaging (fMRI) technology improves, individual i-memes (mental representations of ideas, processes, products) will be more accurately scientifically measured and compared in each case to the equivalent e-meme size (in bytes). Remembering a new word and its meaning is one thing, remembering the precise font, font size, and color that it was written in when perceived also depends on the subject's prior knowledge and awareness of those subdomains in culture, their multiple intelligences (Gardner, 2011), and where they lie on the Sensory Processing Sensitivity (SPS) spectrum, among other variables.

Some Mechanisms and Laws of Cultural Evolution

In biological evolution, the operation of the (macro) evolutionary algorithm on genes is generally viewed as such: variation (mutation of genes), selection (natural, sexual, artificial, or unconscious) operating on the organism in its environment; and heredity (the inheritance of the selected genes by the offspring) (Dennett, 1995).

However there is another (micro) view of the same algorithm, as specifically used in evolutionary computation and Artificial Intelligence. This is the iterative, recursive, evolutionary algorithm of: (1) *selection* (of one or more units from a pool); (2) *variation* (via combination of elements of units; variation can also occur due to mutation and copying errors); and (3) *transmission* (of the new unit) back into the pool, where natural selection (by the environment—including predators, a struggle for survival, selection pressures, fitness landscapes, and falsification) can delete the less-adapted units. This selection-variation-transmission (SVT) systems process operates on a micro level in both biological and cultural ecosystems (see Fig. 8).

In creativity, this "combination of elements" process is Koestler's (1964) "bisociation"; or Fauconnier and Turner's (2002) "conceptual blending"; or Brandt and Eagleman's (2017) "bending, breaking, or blending" process.

In biology, two organisms may select each other (via sexual selection) and blend parts of themselves via DNA to form a new unit (their offspring) and later release that new unit back into "the wild" (the pool), where natural selection may well delete (or archive) it, before it can repeat the algorithm—namely copy 50% of itself via sexual reproduction, and raise its own offspring to reproductive maturity.

In (bio)culture, artists, writers and scientists can *select* i-memes (ideas, processes, products) from their memory, then *vary* or mutate them (via: combination of elements, in their imagination) and *transmit* the new resulting unit back into the e-meme pool, where the field (audience or consumers) can judge it via natural, artificial, or unconscious selection. The new e-meme unit

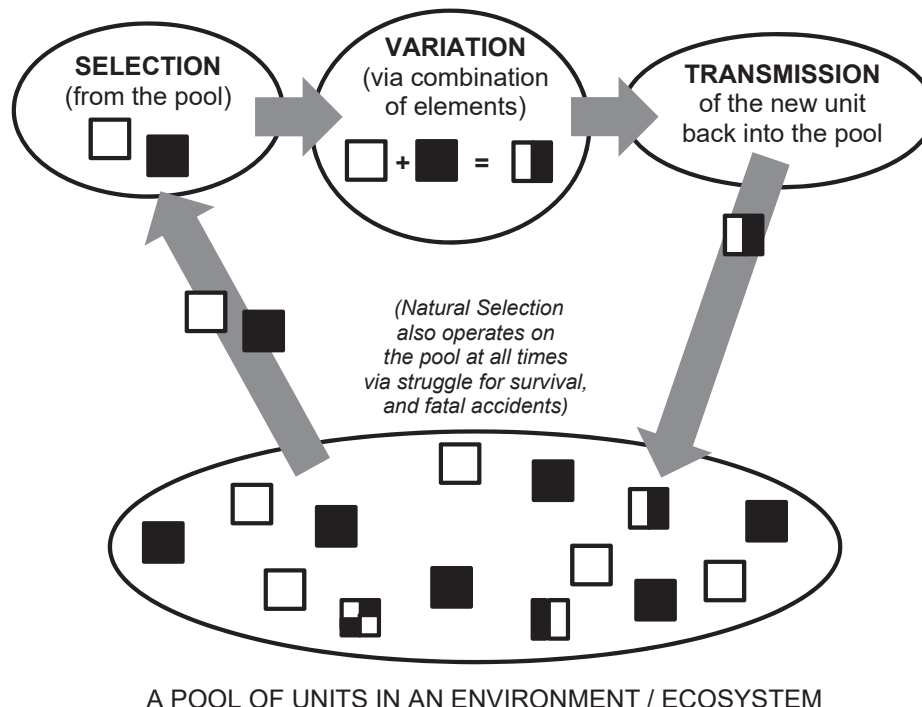


Figure 8 The SVT Evolutionary Algorithm: Selection, Variation, Transmission.

thus becomes either canon or archive in a domain in culture, and this iterative, recursive, algorithmic cycle continues in more human minds. As Colin Martindale expressed it:

“Ultimately, all creative products have this quality: old ideas or elements are combined in new ways. This is the case for all domains of creativity”.
(Martindale, 1989, p. 212)

Emerging from The Newcastle School of Creativity (see McIntyre et al. 2018), Velikovsky's (2016a) model of cultural evolution synthesizes aspects of Csikszentmihalyi's sociocultural systems model of creativity, Simonton's BVSR model of creativity, Bourdieu's practice theory and Sawyer's (2012, p. 218) nested audiences model. The resulting Creative Practice Theory evolutionary systems model of creativity that underpins this view of the holon/parton structure of the meme, the unit of culture, appears in Fig. 9.

In this (macro-scale) Domain, Person, Field bio-psycho-socio-cultural interaction model: The *Person-system* contains a (micro-scale) Memory, Imagination, Judgment interaction (or MIJi) system within their mind, and uses an evolutionary process of Blind Variation (via imagination, or “mental simulation”) and Selective Retention (judgment, and memory) to generate viable new memes–(and discard unlikely ones)–as i-memes, which they can then present (transmit) to the field as e-memes (tangible cultural artifacts). The Field then judges these e-memes (ideas, processes, products). Around 1% of these e-memes either go into the domain's canon (e-memes judged as creative; new and useful) and the other 99% go into archive (e-memes judged not creative, and which are ignored or forgotten by the Field, and thus rarely reappear as e-memes). The canon for a specific domain in culture thus changes over time as better solutions and additional new problems emerge.

Multi-level selection in evolutionary algorithms operating on units in biology (genes, DNA, cells, organisms, groups, superorganisms, species) and also on memes in culture (ideas, processes, products; or culture at various levels of the holon/parton) thus results in biological and cultural survival and extinction; growth and decay; creative and uncreative artifacts; or more simply, canon and archive.

In a statistical sense, biology and culture are similar in that 99% of Earth's biological species have gone extinct over time, due to evolutionary algorithms and multi-level selection operating in the ecosystems of a changing Earth environment, and likewise, around 99% of cultural artifacts are deselected (rejected) by the Field and become archive.

“Viral” Memes a.k.a. Creative Units of Culture

A “viral” meme is simply a term for what many scientists, artists, engineers, inventors and cultural practitioners aim to create, namely a creative unit of culture—or in other words, an idea, process or product whose time has come according to the consensual judgment of the field. How widely the new unit spreads in a domain as an e-meme—and thus in the minds of the field as an i-meme—ultimately determines where exactly on the 5-C spectrum of creativity (Fig. 10) the meme resides in the judgment of the current field.

Fig. 10 is a synthesis of The Four-C Model of creativity (Kaufman and Beghetto, 2009, 2013), and the fifth category of “boldface-C Creativity” (Simonton, 2010, p.175). Instances of Everyday creativity occur frequently as people solve their everyday problems in new and useful ways, but the wider field for that domain (everyday people in everyday life) is rarely aware of these. Meanwhile on the 5-C spectrum of creative memes (Fig. 10), selling a million units of a book, movie, song or videogame (“pro-c” creativity) is considered impactful, and Eminent Genius level (boldface big-C) Creativity is legendary creativity (e.g., Einstein, Picasso, Mozart, Kubrick, Austen). Darwin's theory of evolution (in both biology and in culture) is thus a “category 5” meme (boldface big-C Creativity); as are Newton's and Einstein's theories of gravitation; Da Vinci's *Mona Lisa*; The Beatles' *Sergeant Pepper's Lonely Hearts Club Band*, Michael Jackson's *Thriller* and Led Zeppelin's *IV* albums; Beethoven's *fifth Symphony*; many of Shakespeare's phrases. Category 5 memes have obvious spreading power as problem-solutions. These are re-communicated in culture—in part, or as wholes—depending on the size of their memorable “chunks” in Miller's (i-meme) terms, or bytes in (e-meme) Shannon information. On this view, the Abrahamic religions of Judaism, Christianity, and Islam are also category 5 creativity, given they exist as i-memes in around 53% of the world's 7.6 billion human minds. Conversely there are over 4000 recorded deities in culture, many of which are now archive as i-memes (See “Godchecker” in Relevant Websites).

Stories (Narremes) as Memes

Stories (narratives) are also units of culture. Memes (of both the i-meme and e-meme type) include “narremes”, or *units of story*, which—being memes—are also structured as holon/partons. Gottschall (2012) noted that a narrative is an algorithm, of the formula: *Story = Character(s) + Problem(s) + Attempted Solution(s)*. One popular story algorithm is the “monomyth” or hero's journey (Campbell, 1949), which can be seen as an algorithm for creative problem solving on a macro scale, for example when applied to the life work of biologist/writer Charles Darwin and the filmmaker/writer Stanley Kubrick, and on a micro scale when applied to their individual creative projects (Velikovsky, 2018b). Velikovsky's Ph.D. study (2016b) examined 40 units of culture, comparing traits of the top 20 Return-on-Investment (most profitable) movies (as canon) to the bottom 20 Return-on-Investment (biggest money-losing) movies (as archive). The memes on all unitary levels in a movie (including its narremes—as memes) can be counted and measured, including individual dialogue lines, words and phonemes spoken by actors, words sung on a soundtrack, and so on. Movies are

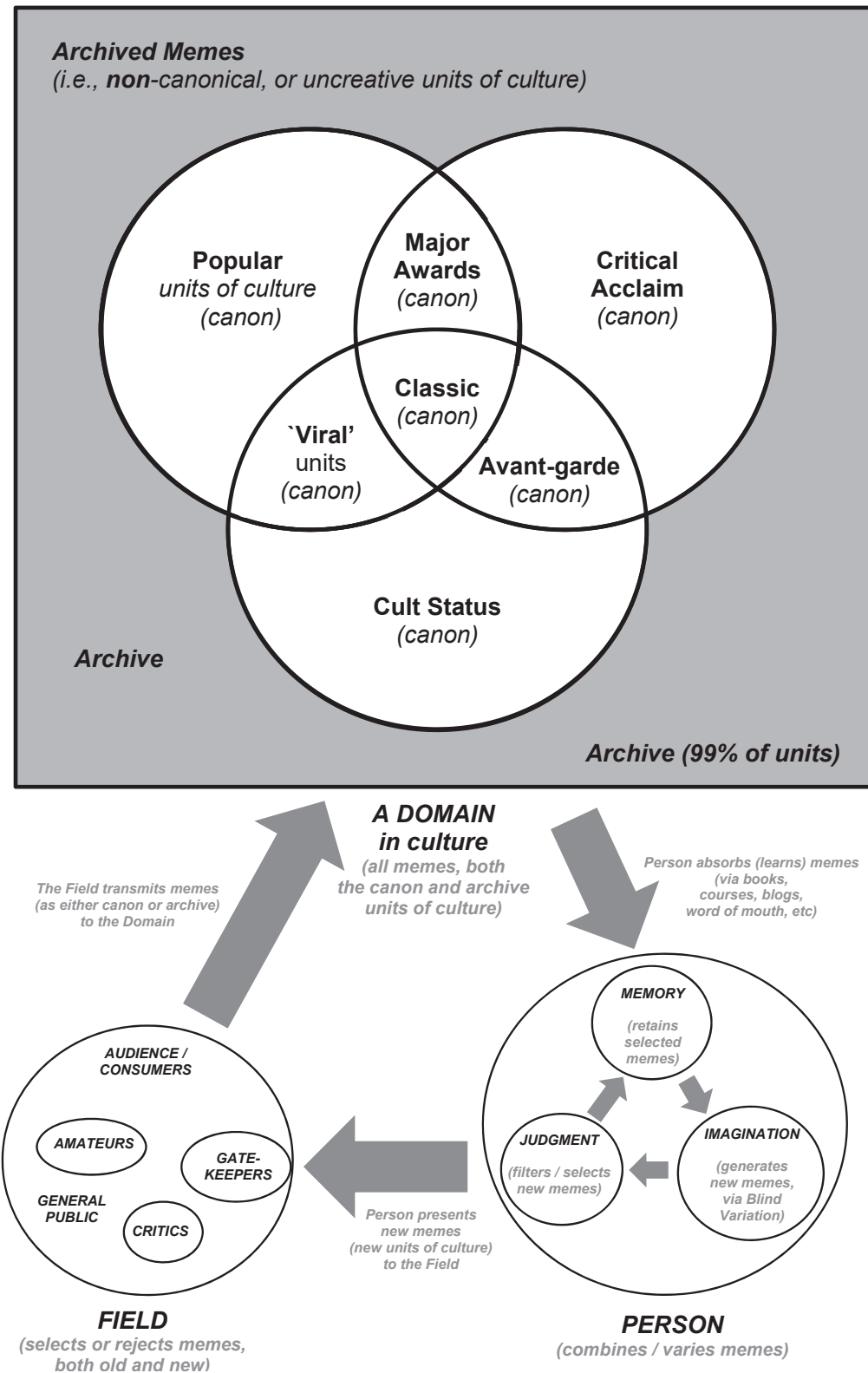


Figure 9 DPFi and MIJi systems, and Seven Categories of Canon (and one of Archive) in a Domain. Adapted and synthesized from Velikovsky, J.T., 2017b. Introducing 'The Robo-Raconteur' artificial writer - or: can a computer demonstrate creativity? *Int. J. Art Cult. Des. Technol.*, 6, 42-3 and Velikovsky, J.T., 2016a. The holon/parton theory of the unit of culture (or the meme, and narreme) in science, media, entertainment and the arts. In: Connor, A., Marks, S. (Eds.), *Creative Technologies for Multidisciplinary Applications*, IGI Global, New York, p. 228.

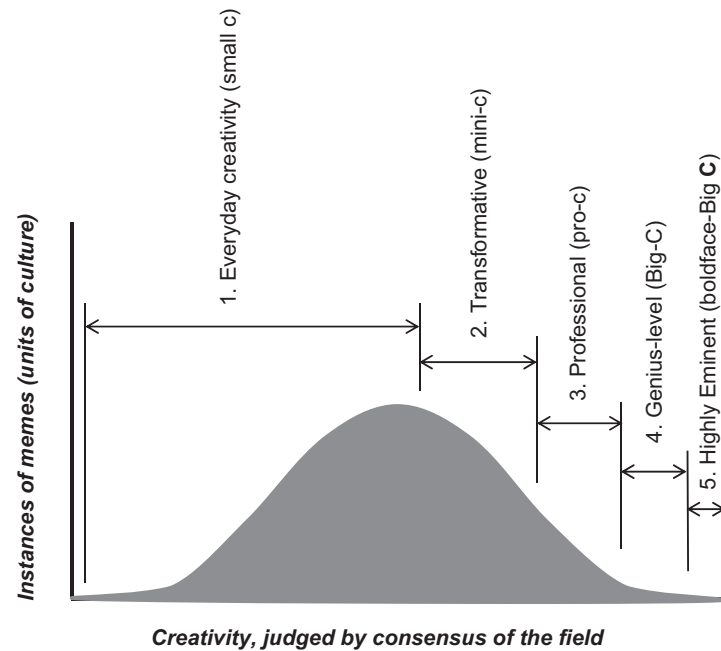


Figure 10 The 5-C spectrum of creativity. Adapted from Velikovsky, J.T., 2018b. Darwin & Kubrick, Joe Campbell & Me: eminent-genius and everyday-joe heroes on a journey. J. Genius Eminence 2, p. 63.

information-rich cultural artifacts, as while a movie screenplay or a novella (as an e-meme) typically contains around 150 kilobytes of Shannon information, the average (90-min) movie is an e-meme of around three gigabytes when digitally compressed as a DVD, and around 250 gigabytes as an uncompressed e-meme (as a movie experienced in a cinema).

Growth of a Unit of Culture

Just as evolution in biology tends to unify “upwards” and to diversify “downwards”, so too inanimate units in culture can, in the broad sense, “grow”. A transmedia story universe, also sequels in the same media, or adaptations of a story universe to other media (such as book-to-film) can result when a unit of culture “expands” in this way. A transmedia universe (such as the *Harry Potter*, *Star Wars*, *DC* or *Marvel* comics universes, also religions, and the scientific history of a domain) grows in this manner as new cultural units are added to it (see Fig. 11).

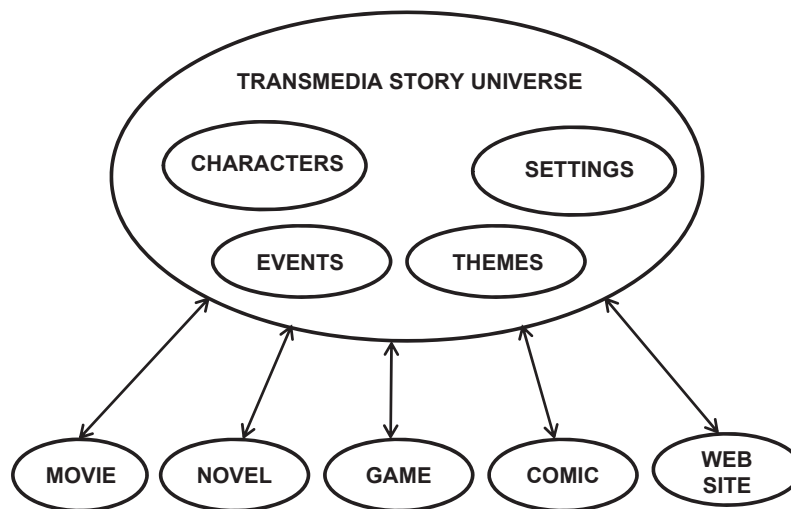


Figure 11 A transmedia fictional story universe, unifying upwards while diversifying downwards, as new units emerge (a novel, movie, game, etc.) and thus new characters, settings, events and themes are added to the whole story universe as a single overarching meme, or unit of culture.

The Creative Practice Theory Model of Cultural Evolution

The model of Creative Practice Theory (Fig. 12) is a Venn diagram, symbolizing that if all of the elements in each set are present (the Domain, Person, Field system; and, Economic, Social, and Cultural Capital), having produced a creative artifact, a creative person may also ultimately obtain Symbolic Capital.

Over time, as more problem-solutions emerge, culture speciates off into discrete, differentiated Domains (see Fig. 13) as technology evolves.

Evolutionary History (Harari, 2015) shows that language led to writing and books; the domestication of fire has led to cooking and the culinary arts; the invention of the wheel led to motorized transportation and electric cars; powered flight has led to aircraft, and so on. As technology complexifies and diversifies (downwards) in Fig. 13, all of these domains also unify (upwards) as elements of human (Earth) culture. We can examine such evolution of culture in broad terms, and track when different disciplines (scholarly academic fields for specific domains) have emerged over time due to advances in technology (see Fig. 14).

Fig. 14 indicates when the first international conference for various domains was held; namely the official origin of a discrete global field of experts for that domain of knowledge in culture. As domains of knowledge fall out of Philosophy, they unify “upwards” into Science and they simultaneously speciate “downwards” into subdomains. For example Evolutionary Biology now includes the subdomains Physiology and Anatomy, Ecology, Neurophysiology, Archeology, Paleontology, Genetics, Epigenetics and more. Conversely, pseudo-sciences such as astrology, psychoanalysis, parapsychology and phrenology have all been archived in the sciences.

Languages and Cultural Evolution

In languages, certain graphemes in English such as “æ” can also be observed going extinct over time. An examination of two alternate spellings of encyclopedia (encyclopaedia, and encyclopædia) via a Google NGram (Fig. 15) demonstrates a three-way battle

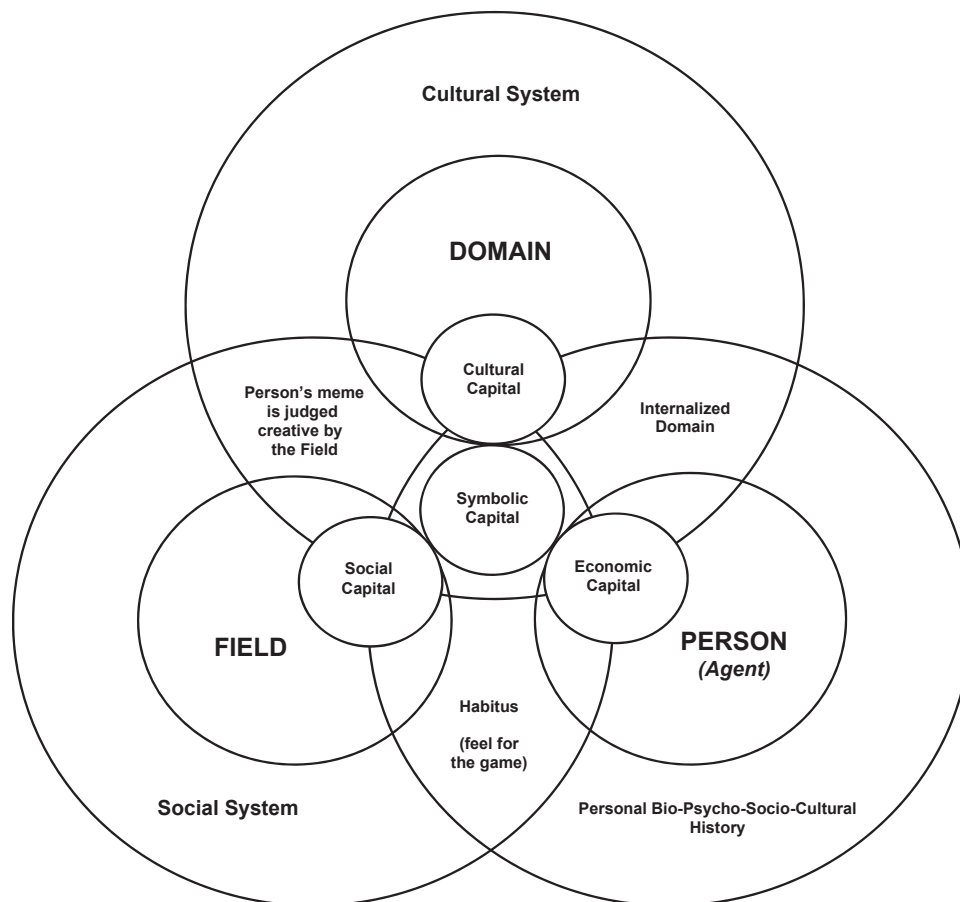


Figure 12 Creative Practice Theory, 2-D model (Velikovskiy, 2016b, p. 61). See the *Glossary* for definitions of Economic, Social, and Cultural Capital, and habitus. An animated 2-D model shows this 12-stage CPT process, over time (see *Relevant Websites*: “Creative Practice Theory”). See also: Sawyer’s “Eight Stages of the Creative Process, and how they correspond to other process models” (Sawyer, 2012, p. 89).

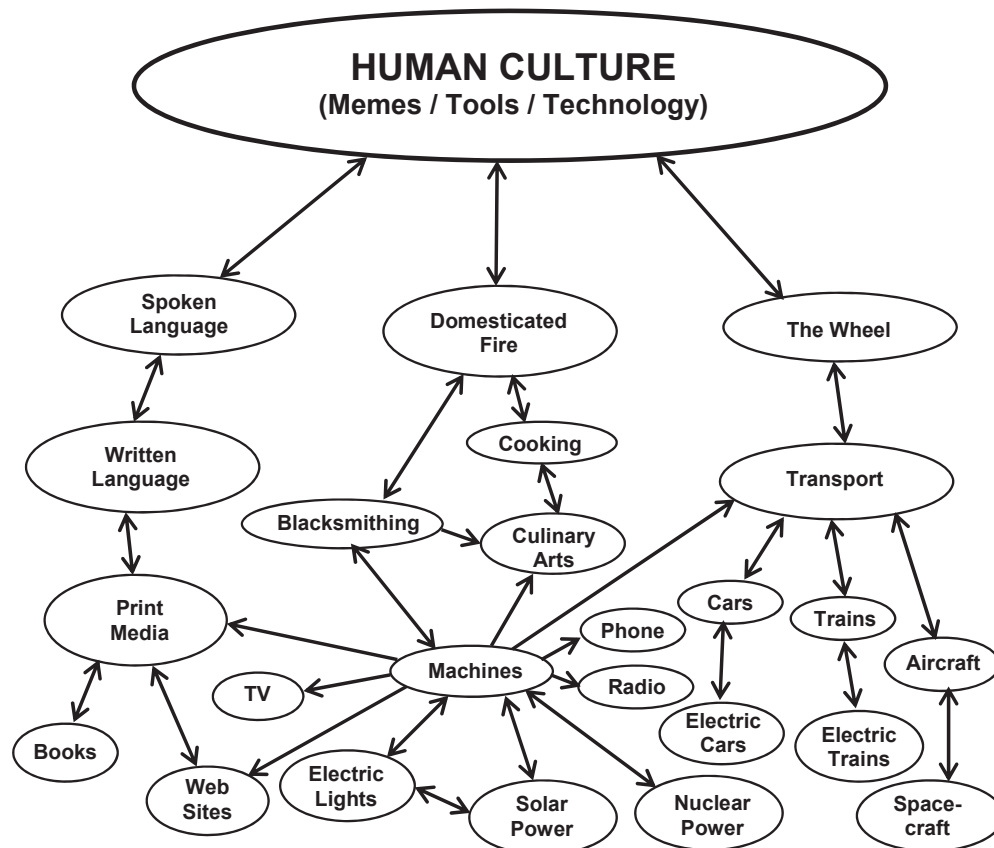


Figure 13 A tree of technology: Unification upwards and complexification downwards in culture.

for survival from 1720 to 1820 and the archiving of “encyclopædia” as the other spellings fill that cultural niche as a problem-solution.

An NGram graph—as a guide to e-meme frequency—can serve as a proxy for the i-memes in circulation during that era.

Summary of Some Mechanisms and Laws in Cultural Evolution

Some of the key mechanism of cultural evolution include: the (micro) evolutionary algorithm of selection, variation, and transmission of i-memes by persons; also the (macro) selection of e-memes as canon by the field for a domain. Some laws in cultural evolution include: the three laws of holon/partons in cultural canon; selection pressure; and unification “upwards” and simultaneous complexification (and speciation) “downwards” in culture as units “grow”.

Memes can be defined rigorously (as: ideas, processes, products) and also mathematized, including via agent-based models and artificial intelligence computer programs. Once i-memes (ideas in Popper’s “World Three”) are expressed as e-memes (in “World One”) they become tangible, concrete, and measurable units. Units of culture (memes) themselves are not able to suffer; do not have anthropomorphic goals, desires, or intentions (a.k.a. problems), but rather, problems (goals) are possessed by the users of technology (humans or other animals). Converting an idea, process or product from a mental i-meme into a physical e-meme is a process of expressing a meme in a physical substrate; the reverse process (perceiving and absorbing an e-meme, thus converting it to an i-meme) is abstracting information from its concrete physical substrate. Certain memes (ideas, processes, products) can also exploit niches in peoples’ worldviews via cognitive biases. If a meme (and its resulting behavioral effects) reduces psychological stress or anxiety, it may not matter to the user if it is true (including chain letters, conspiracy theories, religious or political beliefs).

Creativity as By-Product of the Evolutionary Algorithm

In either biology or in culture, when units exist in a pool inside an ecosystem and compete for finite resources (such as food, shelter, and mates in biology; or human attention and dominance in culture)—and units are selected, varied (combined) and transmitted back into the pool—some will be better-adapted to that environment than others. Selection pressure separates these units into *canon* (new and useful; novel and appropriate; original and adaptive; unique and effective) and conversely, *archive* (uncreative). On this view, creativity is an inevitable byproduct of the evolutionary algorithm operating in ecosystems. The genes—and the memes—that

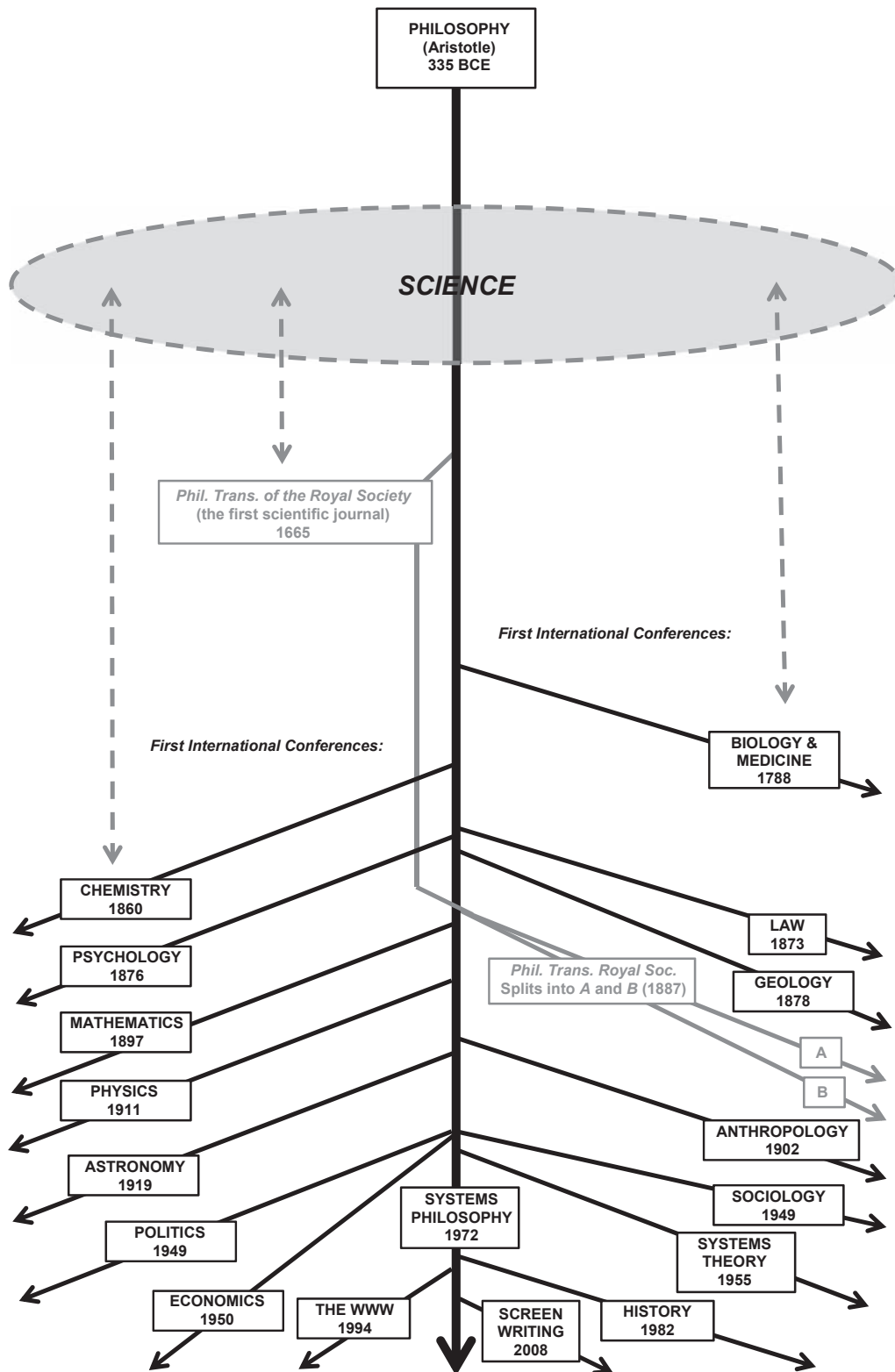


Figure 14 A Tree of Culture: A timeline of the emergence of international fields for domains. (Timeline is not to scale, but is compressed for reasons of clarity.)

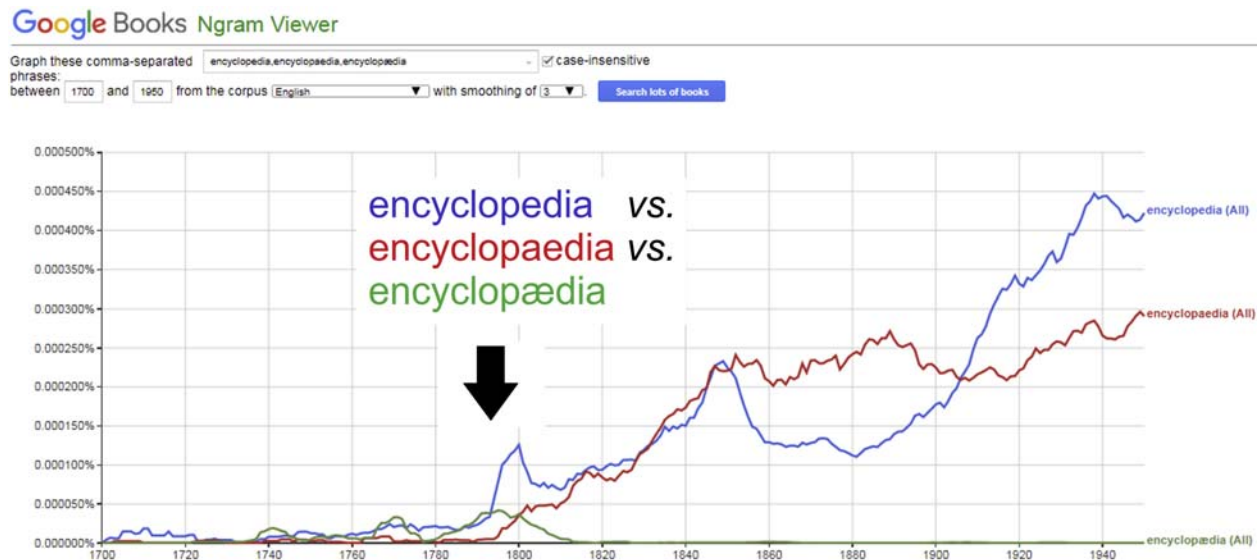


Figure 15 A Google NGram of the words “encyclopedia”, “encyclopaedia”, and “encyclopædia”.

are extant (or canon) rather than extinct (or archive) are the most creative ones, as judged by the environment. In broadest view, humans construct bio-cultural (technological) niches via creativity, using memes as problem-solving tools.

Biology Contains Culture

Organisms are systems with algorithms (processors) inside them. If culture is viewed as *information*, then biology contained internal culture (i-memes) when Life first emerged—three billion years before *Homo Sapiens* appeared—let alone before humans invented external culture (e-memes) such as language, domesticated fire, the hand-axe, the wheel, writing or the internet. A new formal definition of information was proposed by Colgate and Ziock (2011) which incorporates this view, and sees culture as symbiotic rather than parasitic in biology. Some i-memes may be viewed as mental parasites, or a “mind virus”. However in each specific case, we can examine the benefit/cost ratio of the e-meme and i-meme (the idea, philosophy, worldview; process; or product) to determine its overall value to life and society in terms of its behavioral effects, and bio-psycho-socio-cultural as well as ecological impacts.

New and Useful Solutions to Grand Challenges in Cultural Evolution

In 2017 the founders of the Cultural Evolution Society published an article on the eight current major “Grand challenges for the study of cultural evolution” in *Nature* (Brewer et al., 2017). The holon/parton structure of the meme model of culture impacts these challenges, shedding light on some prior mysteries.

Conclusion

A meme, a unit of culture, is a problem-solution in the form of an idea, process or product. Some memes exist as two or all three of these categories (the *idea* of a journey; all the *processes* involved in a journey; the physical journey in space-time involving many e-memes (*products*, such as photographs); and the i-meme memory of the completed journey).

Units of culture (memes) exist because all creativity, like all life, is problem-solving. Problems (goals) emerge with life, and also from human goals (or problems) such as those on Maslow’s hierarchy of needs.

The unit of culture can be viewed as the holon/parton, in all canonical domains in culture. These units can be counted, tracked and measured with some accuracy with regard to e-memes (external units) using Big Data research tools from the Digital Humanities (Google NGrams, citation counts, unit sales, library holdings, and so on) whereas i-memes (as individual human mental information) are much harder to accurately track given how much—and how fast—information constantly circulates in global human minds.

New units of culture emerge from evolving bio-psycho-socio-cultural-economic systems as an inevitable byproduct of the evolutionary algorithms operating on biology, and on culture. The creative units (around 1%) become cultural canon, while vastly more (around 99%) become archive. As problem-solutions, units of culture (memes) can impose some order on the chaos of the universe, in spite of the three laws of thermodynamics.

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Technology: Networks and Maps in Creativity Research, 1999–2018

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Introduction

From ancient poets and architects to modern scientists and engineers, creativity is the fuel for societal and technological development. Accordingly, understanding creative individuals, events, processes and outcomes has been a major topic of scientific inquiry, with scholarly investigations spanning an array of fields from psychology, education, sociology to management (Amabile, 1996; Amabile and Kramer, 2011; Runco, 2015; Runco and Acar, 2012). Yet, while most scholars from different disciplines have come to a common understanding of creativity as the production of novel and useful ideas (Amabile, 1983), the focuses and approaches to examining creative individuals and processes vary to a large extent (Ellamil et al., 2012; Gino and Ariely, 2012; Zhang et al., 2019; Zhang et al., 2015). Researchers in cognitive and neuroscience, for instance, view creativity as resulting from activation of certain brain regions (e.g., Zabelina and Robinson, 2010; Dietrich, 2007; Dietrich and Haider, 2017), whereas studies in the fields of management and applied psychology deem creativity as a product of organizational systems and social interactions (e.g., Hargadon and Bechky, 2006; Nijstad and De Dreu, 2012; Zhou et al., 2008; Zhou and George, 2001).

The myriad of foci and topics around creativity makes it necessary to clarify the spatial structure of the creativity as a research field, as well as similarities, differences, and interrelations among different research paradigms. Employing social network and co-word analysis, Zhang et al. (2015) have recently shown a knowledge map that summarizes 4575 published articles in the broad domain of creativity from 1992 to 2011. In particular, the authors adopted K-core of social network analysis and co-word analysis to draw the key words network and the spatial structure of research topics and paradigms in creativity. They inferred five main topics: creativity applications, pathology & physiology of creativity, individual creativity, organizational creativity, and theories and methodologies. In addition, there have been other maps of the creativity research (e.g., Williams et al., 2016).

Such a knowledge map, on top of discovering the current state of research, allows us to better understand research hotspots and recognize further opportunities. This chapter attempts to update Zhang et al. (2015) by including a larger, more recent sample of articles published between 1999 and 2018. Given that creativity research abounds in the past few years, such an update may result in a somewhat different map, extending our understanding of major topics and their interconnections across fields. In the subsequent sections, data source and collection procedure will be explained, followed by data analysis. Major findings will be discussed and compared to Zhang et al. (2015). The chapter will conclude with implications for future research avenues.

Data Source

The publication data in creativity research were extracted from the core collection database in the Web of Science, which contains more than 12,000 peer-reviewed academic journals covering natural sciences, engineering, biomedicine, social sciences, arts and humanities. The earliest data date back to 1900. The core collection of Web of Science includes references cited in a paper and a unique citation index based on cited author, affiliation, title, keywords, abstract, the number of citations, source, and publication year. This database includes eight sub-libraries: Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index-Science (CPCI-S), Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH), Emerging Sources Citation Index (ESCI), Current Chemical Reactions

(CCR-EXPANDED), and Index Chemicus (IC). Based on our research purpose, three related core sub-libraries—SCI-EXPANDED, SSCI, and A&HCI—were selected as the final sources of data.

As the abstract provides a summary of the content of the document in a concise and precise manner, it includes the aim and scope of the research, the methods used, the results and main conclusions, which is an independent, self-evident, and abbreviated form. Thus, while we did not read the original text verbatim for every article, we were able to grasp its essential information from the abstract.

In order to reveal the paradigm structure and knowledge mapping of creativity research, the publication data were retrieved from the cited papers whose abstracts contain “creativity”. Specifically, as representing the “abstract” in the Web of Science database, “topic” was selected as the search condition and “creativity” was entered as the query content. Meanwhile, the time span was set to 20 years (1999–2018), matching that of Zhang et al. (2015). This procedure resulted in 19,084 papers extracted that contain “creativity” in their abstracts. Further, “noise” papers whose document types are book review (1106), editorial material (960), review (746), proceedings (634), meeting abstract (454), letter (107), book chapter (93), news item (44), biographical item (35), or correction (33) were deleted. The number of papers retained with the “article” document type is 15,571. Thirdly, the citation rate of a paper illustrates its contribution to filed research. If the paper has never been cited by others, it will not be included in our research data for analyzing paradigm structure and knowledge map. Since the papers published in 2018 were very recent, and it takes some time for citations to appear for an article, the papers which was not cited by others in 1999–2017 were deleted, which further reduced the number of papers to 12,926. Finally, the co-word analysis requires at least two keywords per article. Therefore, papers with no keywords (1,012) or only one keyword (310) were deleted, which yielded the final sample of 11,604 papers to be analyzed. The annual published papers included in the final analysis are shown in Fig. 1, which indicates that the number of papers published in the field of creativity has increased year by year in the past 20 years.

Methodology

Originally developed by sociologist Harrison White in 1960s and extended by his successors by combining mathematical analysis with graph theory, social network (SN) represents a set of actors as well as their relationships. The actors and relationships, as visualized by nodes and ties in social network programs (e.g., UCINET), then serve as data source for various analyses. Recognizing its analytical power, scholars in information science have recently adopted SN analysis to examine research collaboration and citation networks (Otte and Rousseau, 2002). To date SN method has proved a powerful tool in understanding “small worlds” of scientific communities (Newman, 2001) and self-organizing nature of international co-authorships (Wagner and Leydesdorff, 2005). It can also reveal the network of keywords in published articles in a given research domain. As it is critical to understand internal structure of a SN (Scott and Carrington, 2011), the method of K-core, with its advantages in citation analysis, paradigm identification, and knowledge map building (Wasserman, 1994), was used to uncover how subgroups make up the whole keyword network.

Second, the basic tenet of co-word analysis is that keywords in a single paper represent the main subject areas of that paper (Ding et al., 2001). As a content analysis method to assess theme ties in a specific topic area, co-word analysis can display its research structure based on keyword frequency. By extracting keywords or theme words from the literature and retaining those of high frequency using a set threshold, it was able to count the frequency that each pair of keywords simultaneously appears in the literature, and form the co-word matrix, which helps us understand hot topics and structure of co-keywords or co-theme words (Ding et al., 2001). Following previous bibliographical research in different disciplines (see Zhang et al., 2015 for a review), co-word

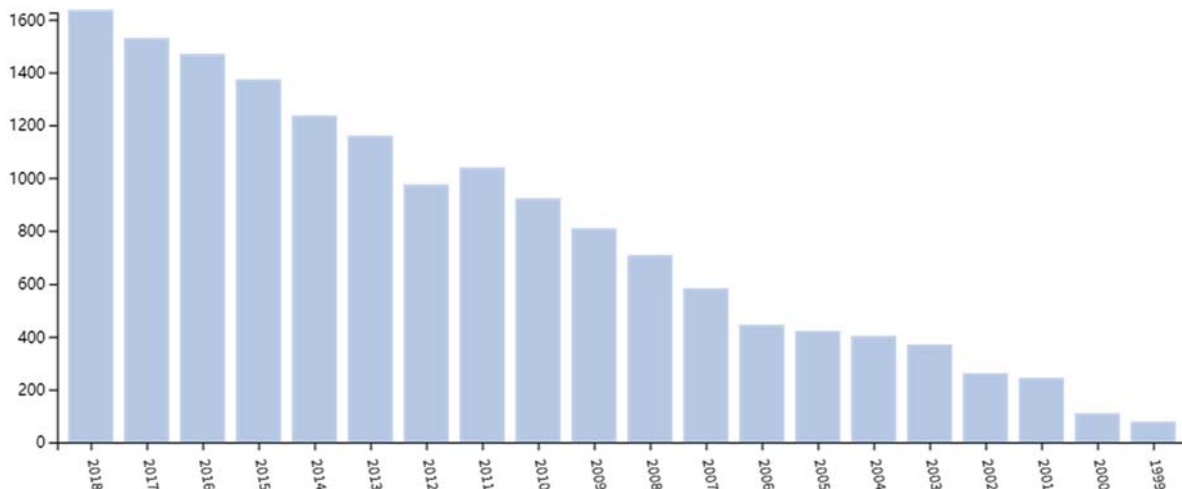


Figure 1 The annual number of publications included in the data.

analysis was employed to map the research structure of the creativity field, which then reveals associations of keywords as well as paradigms and sub-communities.

Furthermore, to illustrate the extent topics and academic communities are connected to or separate from one another, a distance-based measure—multi-dimensional scaling (MDS) was adopted—to classify samples or variables with many dimensions by similarity (distance). Specifically, MDS will generate a map of objects denoted by points, with similar objects (points) gathering together to form a category. The level of centrality of a point in the network shows the importance of the point (object). Following [Zhang et al. \(2015\)](#), Non-metric MDS was employed, as it allows analyses of ordinal scale data.

Fourth, visual analysis is a recent development in information technology. It can process and visualize abstract data, clarify and transform complex and fuzzy data, and uncover hidden information in the data. Such a technique integrates research theories with various methods from fields such as graphics, data mining, human-computer interaction, cognitive science, and image technology. CiteSpace program was used to visualize data and develop knowledge map. CiteSpace can find authors, journals, quoted words, and keywords in the literature, explore their connections, and eventually identify trends in the topic area.

Data Description

Data collected for the study contain a total of 26,557 authors and 11,604 papers between 1999 and 2018, with an average of 2.29 authors per paper. Among them, the top 25 authors who published their papers on creativity are listed in [Table 1](#). For instance, Kaufman of the University of Connecticut ranked first, with 73 publications on creativity. Fink and Benedek, both from Karl Franzens University Graz, ranked second and third respectively, followed by Mumford (University of Oklahoma), Silvia (University of North Carolina Greensboro), and Simonton (University of California Davis), all of whom had published more than 40 articles. Karwowski of Maria Grzegorzewska University, Qiu of Southwest University in China, Runco of University of Georgia, De Dreu of Leiden University, Nijstad of University of Groningen, and Lubart of University of Paris ranked seventh to 10th. Of eleven authors in the top ten, five were from the United States, five from Europe (two from Austria, two from the Netherlands, and one from France), and one from China.

In addition, the 11,604 papers involve 6,918 universities or research institutes, representing a rather broad base. The top 25 institutions that published creativity papers are shown in [Table 2](#). Among them two were from the Netherlands, three from the United Kingdom, one from Canada, two from China, one from Australia, and the remaining 16 were all from the United States. It is apparent that most creativity research were conducted by scholars from research institutions in the North America and Europe. Interestingly, two Chinese universities, one from Hong Kong and the other from Taiwan, are also among the top 25, which demonstrates that universities and institutions outside the United States and Europe have also developed research capability in the field ([Table 3](#)).

Table 1 Top 25 authors by publication count.

<i>No.</i>	<i>Names</i>	<i>Frequency</i>
1	Kaufman JC	77
2	Fink A	44
3	Benedek M	43
4	Mumford MD	42
5	Silvia PJ	41
6	Simonton DK	40
7	Karwowski M	37
8	Qiu J	35
8	Runco MA	35
10	De Dreu CKW	34
10	Lubart T	34
10	Nijstad BA	34
13	Neubauer AC	33
14	Zhou J	32
15	Beaty RE	27
16	Choi JN	26
16	Sternberg RJ	26
18	Glaveanu VP	25
19	Memmert D	24
19	Plucker JA	24
19	Reiter-Palmon R	24
19	Zhang QL	24
23	Chen HC	23
23	Zhang LF	23
25	Baas M	22

Table 2 Top 25 affiliations by publication count.

<i>No.</i>	<i>Affiliations</i>	<i>Frequency</i>	<i>Country</i>
1	Harvard University	149	United States
2	University of Amsterdam	129	Netherlands
3	University of Toronto	122	Canada
4	University of Groningen	105	Netherlands
5	University of Illinois	105	United States
6	University of North Carolina	104	United States
7	Columbia University	97	United States
8	University College London	95	United Kingdom
9	University of Connecticut	95	United States
10	Pennsylvania State University	92	United States
11	Northwestern University	88	United States
12	University of Michigan	88	United States
13	University of Pennsylvania	84	United States
14	Stanford University	82	United States
15	University of Cambridge	82	United Kingdom
16	University of London	82	United Kingdom
17	University of Maryland	80	United States
18	University of California, Berkeley	79	United States
19	City University of Hong Kong	78	China
20	Monash University	78	Australia
21	National Taiwan Normal University	77	China
22	Georgia Institute of Technology	75	United States
23	New York University	75	United States
24	University of California, Davis	74	United States
25	Yale University	73	United States

As for country or region distribution, nearly half of 11,604 papers were from United States (43.8%), followed by United Kingdom (17.7%). P.R. China, combined with Taiwan, counts 1,520 articles (13.1%). Together, researchers from the US, UK

Table 3 Top 25 Countries or regions by publication count.

<i>No.</i>	<i>Countries or regions</i>	<i>Frequency</i>
1	USA	5,082
2	UK	2,056
3	PR China	997
4	Germany	850
5	Australia	798
6	Canada	679
7	Netherlands	624
8	Spain	578
9	France	534
10	Taiwan	523
11	Italy	441
12	South Korea	296
13	Sweden	288
14	Israel	286
15	Denmark	237
16	Russia	223
17	Turkey	217
18	Poland	209
19	Finland	199
20	Brazil	197
21	Japan	195
22	Switzerland	191
23	Austria	183
24	Belgium	162
25	New Zealand	161

and Chinese region had published about three fourths of articles around creativity, representing three major countries/regions. Additionally, besides developed countries/regions, emerging economies such as Russia and Brazil were also on the list.

Table 4 lists the top 25 articles by citation count, which is generally regarded as a measure of scholarly impact and contribution. **Burt's (2004)** paper on structural holes and creativity (published in *American Journal of Sociology*) ranked first, with a total of 1637 citations. **Peck's (2005)** work on analysis of the reception and ramifications of creativity policies in the city of Amsterdam (published in *International Journal of Urban and Regional Research*) received second most citations (966). The third most cited article (739) was **Zhou and George (2001)**, who theorized that useful feedback from coworkers, coworker helping and support, and perceived organizational support for creativity should each interact with job dissatisfaction and continuance commitment to result in creativity (published in *Academy of Management Journal*). **Deci and Ryan's (2008)** paper (published in *Canadian Psychology*), ranked fifth with 700 citations, links creativity to motivation. Overall, the top 25 articles cover a wide range of disciplines including sociology, psychology, management, public administration, economic geography, health care, etc. Among the 25 articles 13 were published in *Academy of Management Journal*, *Journal of Applied Psychology*, or *Leadership Quarterly*, all of which belong to the broad management domain, indicating a burgeoning area of research among management scholars in the last twenty years.

The preceding tables and descriptions summarize top authors, institutions, countries/regions, and articles by citation count. To help creativity scholars better understand potential journal outlets for papers around creativity, the number of publications by journal and listed top 25 journals that published creativity papers was counted. As shown in **Table 5**, *Creativity Research Journal* had published 543 articles, significantly outnumbering all the rest. *Thinking Skills and Creativity* and *Journal of Creative Behavior* ranked second and third, together with a total of 540 publications. The journals that contributed to most publications range from domains of psychology and management, to those of design and education.

Data Analysis

Author Co-occurrence Analysis

To understand the pattern of research collaboration, author co-occurrence analysis was conducted. **Fig. 2** illustrates authors' social network, which reveal diverse and distributed collaboration relationships. For instance, as shown in the network, there were multiple subgroups of collaborators represented by one or two major scholars. The subgroups were either fairly independent (e.g., the Mumford, Runco, and Simonton subgroups), or clustered together (e.g., the Benedek, Fink, and Neubauer subgroups). Interestingly, the largest cluster was formed by several subgroups led by Kaufman, Karwowski, Silvia, and Beaty). With both heterogeneity and centralization, such a network structure ensured content diversity and knowledge integration, which was beneficial for creativity research to develop as a multi-disciplinary field.

Affiliations Co-occurrence Analysis

Fig. 3 demonstrates authors' affiliation co-occurrence network. At the center were major collaborating universities such as Pennsylvania State University, University of Pennsylvania, Georgia Institute of Technology, University of Connecticut at Storrs, Maryland University and University of Illinois. Based in the US, these universities connected and bridged other universities and research centers in different countries/regions. Albeit ranked first, Harvard was not at the center of the network; rather it grouped with University of Toronto and Graz University on the upper-left corner. The lower-right corner presents a local network including a few UK universities such as Nottingham, Oxford, and University College London. Two Dutch universities—University of Groningen and University of Amsterdam—formed another small collaboration network on the right side of the figure. Finally, some universities from Hong Kong and Taiwan were well connected with universities in California (e.g., Stanford, UC Berkeley, UC Davis).

Countries or Regions Co-occurrence Analysis

University network reflects collaborative research outputs by institutions, whereas countries or regions' collaborative network stand for breath of collaborations across national or regional borders. As shown in **Fig. 4**, in a marked contrast to authors' network, national/regional collaborative network had a rather dense structure, indicating close connections and joint work among creativity scholars around the globe. The US, Canada and Netherlands were located in the center of the network, representing the largest subgroup. Another two major subgroups were led by UK and Germany, which were, respectively, clustered by other European countries. Noteworthy is the subgroup composed of Asian Pacific countries such as The People's Republic of China, Taiwan, Japan, South Korea, Russia and Australia.

Keywords Co-occurrence Analysis

Using Citespace to process the full record data of 11,604 papers, it was able to obtain 30,243 keywords, based on which a keyword network was formed (**Fig. 5**). The figure reveals that keywords were well connected into an integrative network. Although Citespace is good for visualization of social network, it is limited in in-depth analysis of co-word occurrence. It thus relied on Bibexcel for the co-word analysis. After importing the full data in Bibexcel, 230 keywords with a frequency greater than 60 were retained. Integrating keywords with the same or similar meaning and combining the singular and plural forms resulted in 216 keywords, which were

Table 4 Top 25 articles by citation count.

<i>No. Authors</i>	<i>Year</i>	<i>Titles</i>	<i>Journals</i>	<i>Citation</i>
1 Burt, R. S.	2004	Structural holes and good ideas	American Journal of Sociology	1637
2 Peck, J.	2005	Struggling with the creative class	International Journal of Urban and Regional Research	966
3 Zhou, J.; George, J. M.	2001	When job dissatisfaction leads to creativity: Encouraging the expression of voice	Academy of Management Journal	739
4 Deci, E. L.; Ryan, R. M.	2008	Facilitating Optimal Motivation and Psychological Well-Being across Life's Domains	Canadian Psychology-Psychologie Canadienne	700
5 Tierney, P.; Farmer, S. M.	2002	Creative self-efficacy: Its potential antecedents and relationship to creative performance	Academy of Management Journal	629
6 Zhang, X. M.; Bartol, K. M.	2010	Linking empowering leadership and employee creativity: the influence of psychological empowerment, intrinsic motivation, and creative process engagement	Academy of Management Journal	628
7 Uzzi, B.; Spiro, J.	2005	Collaboration and creativity: The small world problem	American Journal of Sociology	614
8 Perry-Smith, J. E.; Shalley, C. E.	2003	The social side of creativity: A static and dynamic social network perspective	Academy of Management Journal	613
9 Shalley, C. E.; Gilson, L. L.	2004	What leaders need to know: A review of social and contextual factors that can foster or hinder creativity	Leadership quarterly	516
10 Uhl-Bien, M.; Marion, R.; Mckelvey, B.	2007	Complexity leadership Theory: Shifting leadership from the industrial age to the knowledge era	Leadership Quarterly	510
11 Shin, S. J.; Zhou, J.	2003	Transformational leadership, conservation, and creativity: Evidence from Korea	Academy of Management Journal	505
12 Perry-Smith, J. E.	2006	Social yet creative: The role of social relationships in facilitating individual creativity	Academy of Management Journal	502
13 Gibson-Graham, J. K.	2008	Diverse economies: Performative practices for "other worlds"	Progress in Human Geography	488
14 Friedman, R. S.; Forster, J.	2001	The effects of promotion and prevention cues on creativity	Journal of Personality and Social Psychology	475
15 Whittemore, R.; Chase, S. K.; Mandle, C. L.	2001	Validity in qualitative research	Qualitative health Research	473
16 George, J. M.; Zhou, J.	2001	When openness to experience and conscientiousness are related to creative behavior: An interactional approach	Journal of Applied Psychology	469
17 Jung, D. I.; Chow, C.; Wu, A.	2003	The role of transformational leadership in enhancing organizational innovation: Hypotheses and some preliminary findings	Leadership Quarterly	463
18 De Dreu, Ck; West, M. A.	2001	Minority dissent and team innovation: The importance of participation in decision making	Journal of Applied Psychology	459
19 Rowe, G.; Hirsh, J. B.; Anderson, A. K.	2007	Positive affect increases the breadth of attentional selection	Proceedings of the National Academy of Sciences of the United States of American	455
20 Rose, N.; O'Malley, P.; Valverde, M.	2006	Governmentality	Annual Review of Law and Social Science	454
21 Gong, Y. P.; Huang, J. C.; Farh, J. L.	2009	Employee learning orientation, transformational leadership, and employee creativity: the mediating role of employee creative self-efficacy	Academy of Management Journal	451
22 Janssen, O.; Van Yperen, N. W.	2004	Employees' goal orientations, the quality of leader-member exchange, and the outcomes of job performance and job satisfaction	Academy of Management Journal	445
23 Macarron, R.; Banks, M. N.; Bojanic, D. et. al	2011	Impact of high-throughput screening in biomedical research	Nature Reviews Drug Discovery	441
24 Florida, R.	2002	The economic geography of talent	Annals of the Association of American Geographers	437
25 Park, N.; Pererson, C.; Seligman, Mep	2004	Strengths of character and well-being	Journal of Social and Clinical Psychology	424

Table 5 Top 25 journals by publication count.

<i>No.</i>	<i>Journals</i>	<i>Frequency</i>
1	Creativity Research Journal	543
2	Thinking Skills and Creativity	280
3	Journal of Creative Behavior	260
4	Psychology of Aesthetics Creativity and the Arts	189
5	Frontiers in Psychology	168
6	Personality and Individual Differences	117
7	International Journal of Engineering Education	111
8	Creativity and Innovation Management	96
9	Design Studies	79
10	Journal of Business Research	76
11	Computers in Human Behavior	68
11	International Journal of Technology And Design Education	68
11	PLoS One	68
14	Journal of Product Innovation Management	67
15	International Journal of Art Design Education	65
16	Journal of Organizational Behavior	64
17	Leadership Quarterly	60
18	Academy of Management Journal	59
19	Journal of Applied Psychology	57
20	Pamiętnik Literacki	57
21	Psikhologicheskii Zhurnal	56
22	Digital Creativity	54
22	Social Behavior and Personality	54
22	Voprosy Filosofii	54
25	Learning and Individual Differences	51

used to construct the co-word matrix (Table 6). As shown in the table, “creativity” had the greatest frequency of 5504 times, followed by “performance” (1686), “innovation” (1400) and “model” (1054), all more than 1000 times. In addition, other keywords such as “personality”, “work”, “organization”, “employee creativity”, “divergent thinking”, “perspective”, “behavior”, “knowledge” and “intelligent” had frequency counts of more than 500 times.

With the 216 top keywords (shown in Table 6), Bibexcel was used to establish keywords co-occurrence matrix M , where $M \in R_{216 \times 216}$, partly shown in Table 7. Co-occurrence matrix M contains numbers representing the frequency that each pair of keywords appears in the same article. For instance, 310 shown in the cell located in the third column and the fourth row in Table 7, indicates that the keywords of “creativity” and “divergent thinking” simultaneously appeared in the same documents for 310 times. It should be noted that the numbers on the diagonal of the matrix are all zero, meaning that the same keyword cannot appear in the same article with itself. Next, we applied UCINET 6.0 to conduct the K-core analysis for keywords co-occurrence matrix M , in attempt to reveal the subgroups based on keywords’ network positions. Results show that 216 keywords were divided into 18 subgroups, whose node degrees were, respectively, 54, 53, 52, 51, 50, 49, 48, 46, 44, 42, 41, 40, 39, 38, 37, 35, 33 and 22. The node degrees of 84.3% keywords were above 50, which suggest that most of topics had been simultaneously examined by creativity scholars, and the topics had strong correlations. Furthermore, MDS was employed to observe the spatial positions of the 216 keywords in the keyword network, in hope of finding topic-based classifications and evolutionary paradigms. The keywords network and results of K-core and MDS was visualized by using the software NetDraw, which are shown in Fig. 6.

Discussion

Analyses of 11,604 published articles on creativity from 1999 to 2018 yielded results regarding authors, institutions, countries/regions, and keywords. Our discussion will center on the 216 high-frequency keywords (shown in the K-core and MDS map of Fig. 6), in attempt to uncover broad categories and spatial structure based on which to identify major creativity research domains and point to future research opportunities.

Six Categories of Research Topics

As shown in Fig. 6, the 216 top frequent keywords can be grouped into six broad categories of topics around creativity. At the center of the keyword network are keywords grouped in a purple circle. A close examination reveals that these keywords represent construct space of creativity, major theories on creativity, and methodological terms. In particular, definitions and dimensions of creativity are reflected in such keywords as “originality”, “flexibility”, “idea generation”, “value”, “validity”, “reliability”, “cognition”, and

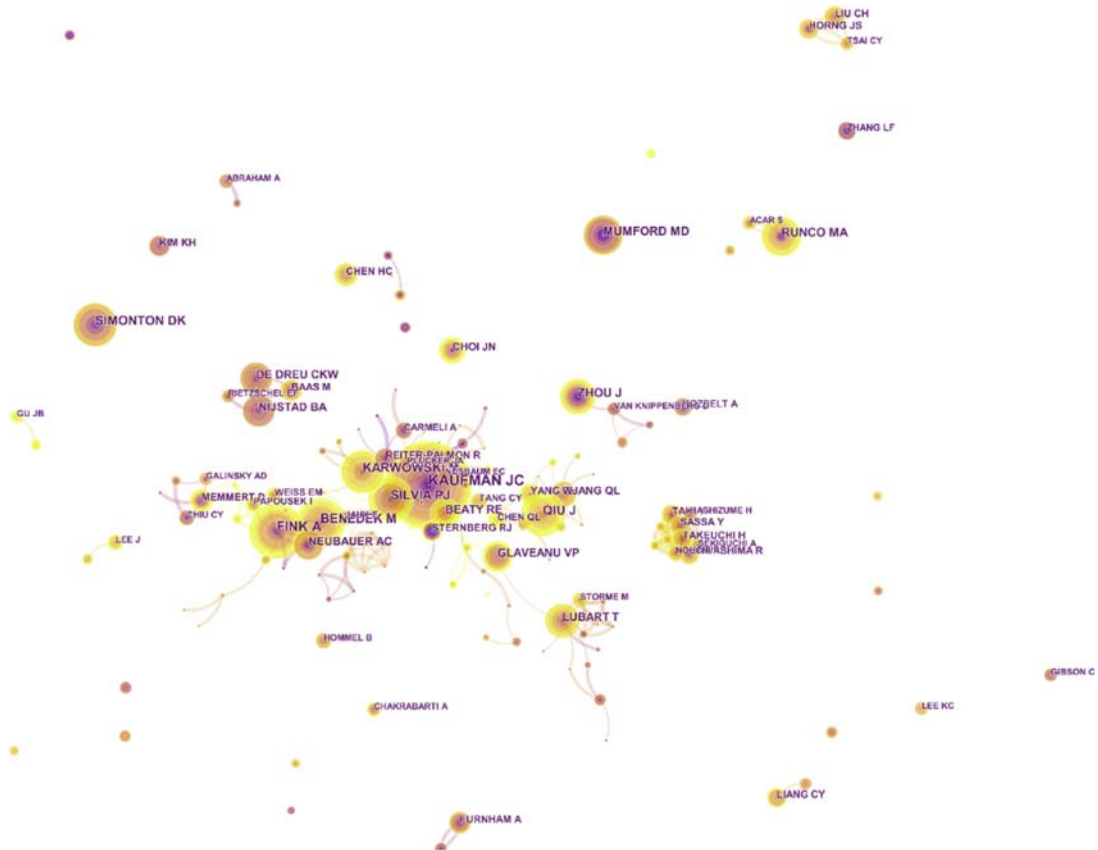


Figure 2 Authors' cooperative network.

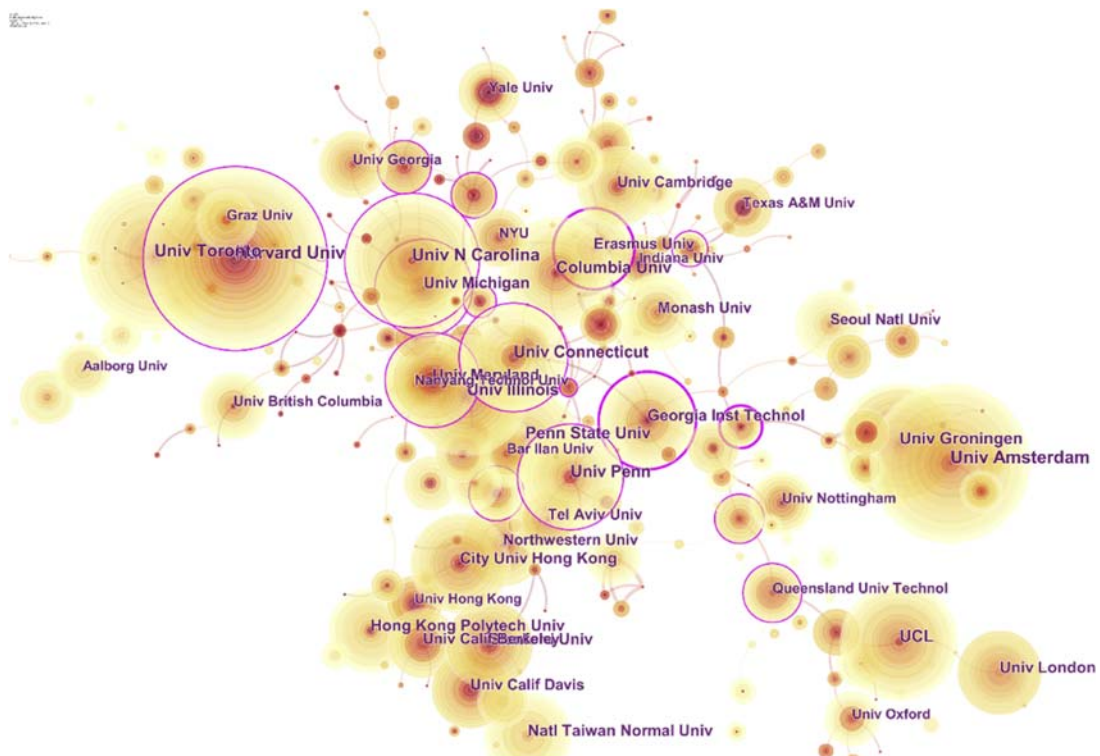


Figure 3 Authors' affiliation co-occurrence network.

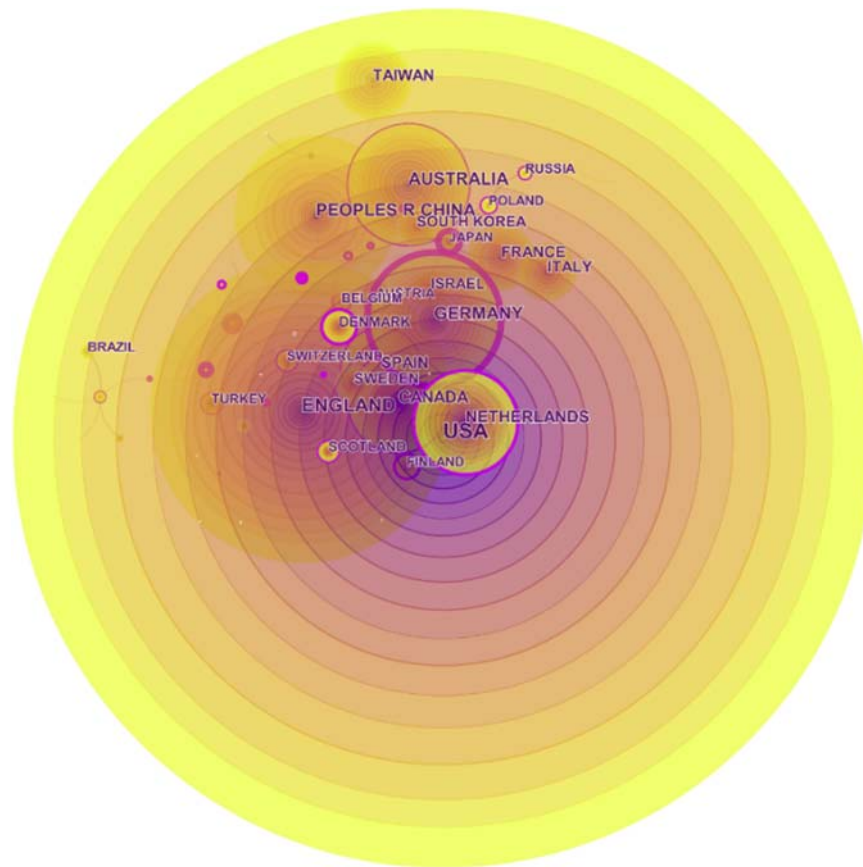


Figure 4 National/regional collaborative network.

"creativity". Other keywords as "brainstorming", "networks", "communication", "collaboration", "integration", "individual-difference" represent key elements or processes of collective creativity. Further, another group of keywords stand for mainstream creativity theories, including some general theory-relevant keywords (e.g., "model", "system", "perspective", and "framework"), as well as specific theoretical approaches such as Amabile's (1983) componential theory of creativity (i.e., "expertise", "knowledge", "information", "divergent thinking", "thinking", "intelligence", "intrinsic motivation", "motivation"), the interactionist perspective stressing the interplay of individual characteristics and task context (i.e., "organization", "technology", "culture", "power", "strategy", "decision making", "time", "innovation", "task", "work", "self", and "behavior"), and their joint effects on performance ("impact", "success", "productivity", and "performance"). Finally, there are a few keywords denoting methodologies applied to the creativity research (e.g., "scale", "meta-analysis", and "validation").

Second, on the lower right side of the figure are 41 keywords (separated by a red circle) that tap into the cognitive and psychological aspects of creativity. Specifically, cognitive and neuroscience approaches to creativity are echoed in a number of words (e.g., "neuroscience", "brain", "language", "similarity", "analogy", "blind variation", "prefrontal cortex", "thought", "EEG", "representation", "activation", "schizophrenia", "schizotypy", "mental-illness", "psychopathology", "bipolar disorder", "memory", "working-memory", "cognitive control", etc.). Likewise, applied and social psychologists have studied creativity with such keywords as "positive affect", "hedonic tone", "self-regulation", "self-determination theory", "stress", "inhibition", "depression", "depression tests", "conceptual design", "creative thinking", "dual pathway", "Torrance tests", "consensual assessment technique", "engineering design", "social-psychology", "implicit theories", and "5-factor model". It is interesting that the keyword "Hong Kong" also falls into this category, probably indicating that a region-based interest in examining creativity from the cognitive-psychological perspective.

The third category, represented as the blue circle, covers topics related to the association of individual characteristics with individual-level creativity. More specifically, these keywords range from personality (e.g., "personality", "openness", "achievement", "psychology", and "trait"), emotion (e.g., "emotion" and "mood"), cognition (e.g., "attention", "perception", and "insight") to other individual-level variables such as "skills", "attitudes", and "gender difference". Together, these keywords demonstrate topic areas in which creativity research have been conducted at the micro level.

Conversely, the fourth category of keywords, a large group in the orange circle on the left side of the network, are mainly from creativity research in the organizational context. Further examination reveals a few sub-categories within this group. First, there are keywords that represent creative contexts, processes, and outcomes within organizations, be at the individual or team level. Examples include "group creativity", "teams", "contextual factors", "work-environment", "diversity", "goal orientation", "regulatory

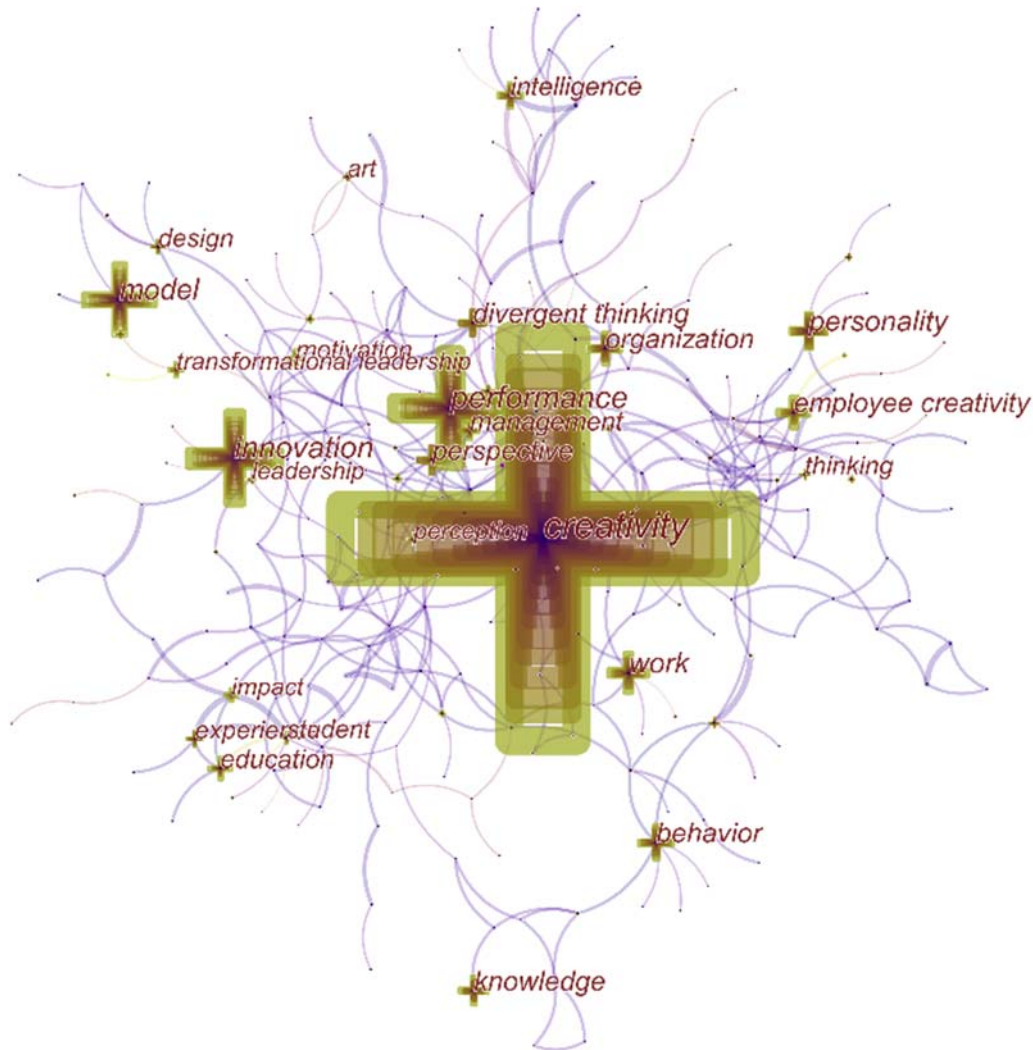


Figure 5 Keywords network.

focus", "self-efficacy", "creative self-efficacy", "social identity", "participation", "identity", "identification", "engagement", "psychological safety", "psychological empowerment", "social network", "climate", "leader-member exchange", "transactional leadership", "transformational leadership", "leadership", "support", "conflict", "trust", "innovative behavior", and "organizational citizenship behavior".

Also in the fourth category, macro level (i.e., organization- or inter-organization level) creativity studies can be shown with such keywords as "firm", "knowledge management", "absorptive-capacity", "research and development", "product development", "exploration", "exploitation", "market orientation", "organization culture", "entrepreneurship", and "organization innovation". Further, there are other keywords dealing with methodological aspects of the studies (e.g., "moderating role" and "mediating role"). Finally, two country keywords—the US and China—also appear in this category, suggesting creativity as a major research area in the broad domain of organization studies in these two countries.

The fifth category, in the yellow circle, comprises keywords representing studies on policies and macroeconomic issues, within which three relevant research areas can be identified: economy and geography (e.g., "cities", "geography", "globalization", "economy", "industry", "growth", "creative industries", and "competitive advantage"), policies (e.g., "politics", "policy", and "government"), and society and environment (e.g., "dynamics", "communities", "context", "environment", "sustainability", and "ethics").

The last category contains keywords (in the green circle) that belong to basic disciplines of education, arts, science, and social science. Specifically, representative keywords include "pedagogy", "learning", "classroom", "children", "adolescents", "teachers", "play", "risk", and "assessment" for education; "aesthetics", "music", "art", "artists", "imagination", and "improvisation" for arts; "patterns", "science", "discovery", "evolution", "life", and "health" for science; and "history", "women", "people", "generation", "gender", and "age" for humanities and social science.

Table 6 Top 216 keywords (frequency ≥ 60).

Rank	Keywords	Frequency	Rank	Keywords	Frequency	Rank	Keywords	Frequency
1	5504	Creativity	73	142	Activation	145	83	Ability
2	1686	Performance	74	142	Determinants	146	82	China
3	1400	Innovation	75	141	Brainstorming	147	82	Hedonic tone
4	1054	Model	76	141	Health	148	81	Implicit theories
5	737	Personality	77	141	Task	149	80	Market orientation
6	669	Work	78	137	Entrepreneurship	150	80	Participation
7	624	Organization	79	136	Job-performance	151	80	People
8	599	Employee creativity	80	135	Conflict	152	79	Economy
9	583	Divergent thinking	81	134	Schizophrenia	153	79	Engagement
10	565	Perspective	82	132	Industry	154	79	Transactional leadership
11	564	Behavior	83	131	Language	155	78	Climate
12	556	Knowledge	84	131	Originality	156	78	Dynamics
13	507	Intelligence	85	130	Contextual factors	157	77	Bipolar disorder
14	435	Education	86	130	Social networks	158	75	Classroom
15	421	Management	87	129	Openness	159	75	Skills
16	391	Design	88	127	Quality	160	75	Sustainability
17	385	Transformational leadership	89	127	Validity	161	74	Globalization
18	363	Thinking	90	124	Validation	162	74	Innovative behavior
19	355	Experience	91	123	Context	163	74	Organizational innovation
20	336	Motivation	92	123	Problem solving	164	74	Play
21	313	Impact	93	121	Time	165	73	Care
22	313	Students	94	117	FMRI	166	73	Ethics
23	304	Perception	95	115	Prefrontal cortex	167	73	Leader-member exchange
24	299	Art	96	114	Research-and-development	168	73	Values
25	293	Leadership	97	113	Evolution	169	72	Assessment
26	290	Firm	98	110	Orientation	170	72	Cognitive control
27	287	Culture	99	110	Support	171	72	Goal orientation
28	281	System	100	107	Imagination	172	71	Computational creativity
29	279	Cognition	101	107	Power	173	71	Exploitation
30	272	Information	102	106	Cities	174	71	Organizational citizenship behavior
31	269	Children	103	106	Psychological empowerment	175	71	Self-determination theory
32	269	Meta-analysis	104	106	Success	176	71	5-factor model
33	257	Intrinsic motivation	105	105	Engineering design	177	70	Curriculum
34	246	Science	106	105	Growth	178	70	Governance
35	240	Technology	107	104	Attitudes	179	70	Selection
36	235	Achievement	108	104	Expertise	180	70	Traits
37	233	Self-efficacy	109	104	Outcomes	181	69	City
38	230	Decision-making	110	104	Stress	182	69	Gender-differences
39	224	Idea generation	111	101	Exploration	183	69	Implementation
40	211	Emotion	112	100	Life	184	69	Metaphor
41	210	Product development	113	100	Reliability	185	69	Representation
42	205	Memory	114	99	Depression	186	69	Risk
43	202	Strategy	115	99	Learning	187	69	United-States
44	200	Environment	116	99	Moderating role	188	68	aesthetics
45	196	Insight	117	99	Policy	189	68	conceptual design
46	193	Identity	118	98	Consequences	190	68	Tests
47	187	Gender	119	98	Future	191	67	Creative self-efficacy
48	186	Individual-differences	120	98	Improvisation	192	67	Discovery
49	186	Networks	121	97	Scale	193	67	Social identity
50	185	Brain	122	97	Workplace	194	66	Geography
51	185	Communication	123	94	Politics	195	66	Mechanisms
52	183	Individual creativity	124	94	Psychopathology	196	65	Hong-Kong
53	183	Productivity	125	93	Adolescents	197	65	Mental-illness
54	182	Mood	126	93	Creative industries	198	65	Patterns
55	180	Collaboration	127	93	EEG	199	64	Psychological safety
56	178	Self	128	93	Identification	200	63	Analogy
57	167	Attention	129	92	Job-satisfaction	201	63	Emergence
58	167	Work-environment	130	92	Women	202	63	Neuroscience
59	165	Psychology	131	91	Consensual assessment technique	203	62	Absorptive-capacity
60	164	Diversity	132	90	Knowledge management	204	62	Organizational culture

(Continued)

Table 6 Top 216 keywords (frequency ≥ 60).—cont'd

Rank	Keywords	Frequency	Rank	Keywords	Frequency	Rank	Keywords	Frequency
61	161	Communities	133	90	Trust	205	62	pedagogy
62	160	Working-memory	134	89	Schizotypy	206	62	Responses
63	157	Generation	135	88	Flexibility	207	62	Similarity
64	156	Framework	136	87	Complexity	208	61	Blind variation
65	152	Artists	137	87	Ideas	209	61	Creative thinking
66	152	Teams	138	87	Predictors	210	61	Self-regulation
67	151	Music	139	87	Thought	211	60	Competitive advantage
68	149	Mediating role	140	86	Age	212	60	Dual pathway
69	146	Positive affect	141	86	Productivity loss	213	60	Group creativity
70	144	Antecedents	142	86	Regulatory focus	214	60	History
71	144	Integration	143	85	Teachers	215	60	Inhibition
72	144	Satisfaction	144	85	Torrance tests	216	60	Social-psychology

Spatial Structure of Creativity Research

The K-core and MDS map in Fig. 6 embodies nodes' (i.e., keywords') relationships via the space and distance. Relevant indices such as density and centralization can be used to evaluate the network and discover sub-groups and their interconnections. The current study employed MDS technique to construct the knowledge map of keywords in creativity research, which provides the spatial structure in this research field. It also updates the knowledge map developed by Zhang et al. (2015). The similar findings were discovered in the two studies. However, the map by Zhang et al. presents five categories, that is, "creativity applications in different areas", "pathology and physiology of individual creativity", "individual-level creativity", "organizational-level creativity", and "basic theories and methodologies". Instead, the current study generated six categories, dividing the category "creativity applications in different areas" into two emerging categories—"policies and macroeconomic issues" and "basic disciplines of education, arts, science, and social science". Such a change suggests an increasing, refined attention to macro-level factors of industries and policies in recent creativity research, indicating a trend to apply well developed theories and frameworks to benefit production and societies. This is also consistent with the general pattern that mature sciences are more likely to be applied into practice.

The structure of the map shown in Fig. 6 features a central group with high density of network ties. The keywords connected through these ties concern core dimensions and definitions of creativity, essential creativity theories, and research methods applied in the area. In addition, the other surrounding groups, marked with different colored circles, contain keywords that represent studies exploring specific topic areas within the creativity domain. Some of these topics are highly specialized and may involve few scholarly conversation and collaboration across topic areas.

From right to left in Fig. 6, the keyword network starts with the group focusing on micro-level processes and mechanisms for individual creativity. For instance, neuroscientists attend to brain mechanisms that can produce creative thinking and ideas, while applied psychologists attempt to link creativity to individual personality, demographics, affect, attitudes, and so on. Further, it should be noted that studies on individual creativity had been conducted in a wide variety of disciplines, ranging from science, education, arts, to social science.

At the left side the group contains keywords that are extracted from articles examining team- and/or organization-level creativity. These studies explored creative processes and behaviors in the organizational context. Moreover, researchers in this line of research

Table 7 Keywords co-occurrence matrix M (fragment).

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Behavior	0												
2. Creativity	32	0											
3. Divergent thinking	0	310	0										
4. Employee creativity	0	183	6	0									
5. Innovation	24	515	19	143	0								
6. Intelligence	4	262	114	8	9	0							
7. Knowledge	2	234	10	25	133	11	0						
8. Model	88	551	75	101	187	57	45	0					
9. Organization	44	281	14	90	174	7	37	61	0				
10. Performance	34	656	102	233	233	72	57	71	79	0			
11. Personality	16	357	107	44	33	114	2	38	22	54	0		
12. Perspective	27	226	9	70	124	10	34	42	66	107	25	0	
13. Work	35	282	13	165	147	3	31	58	45	151	25	17	0

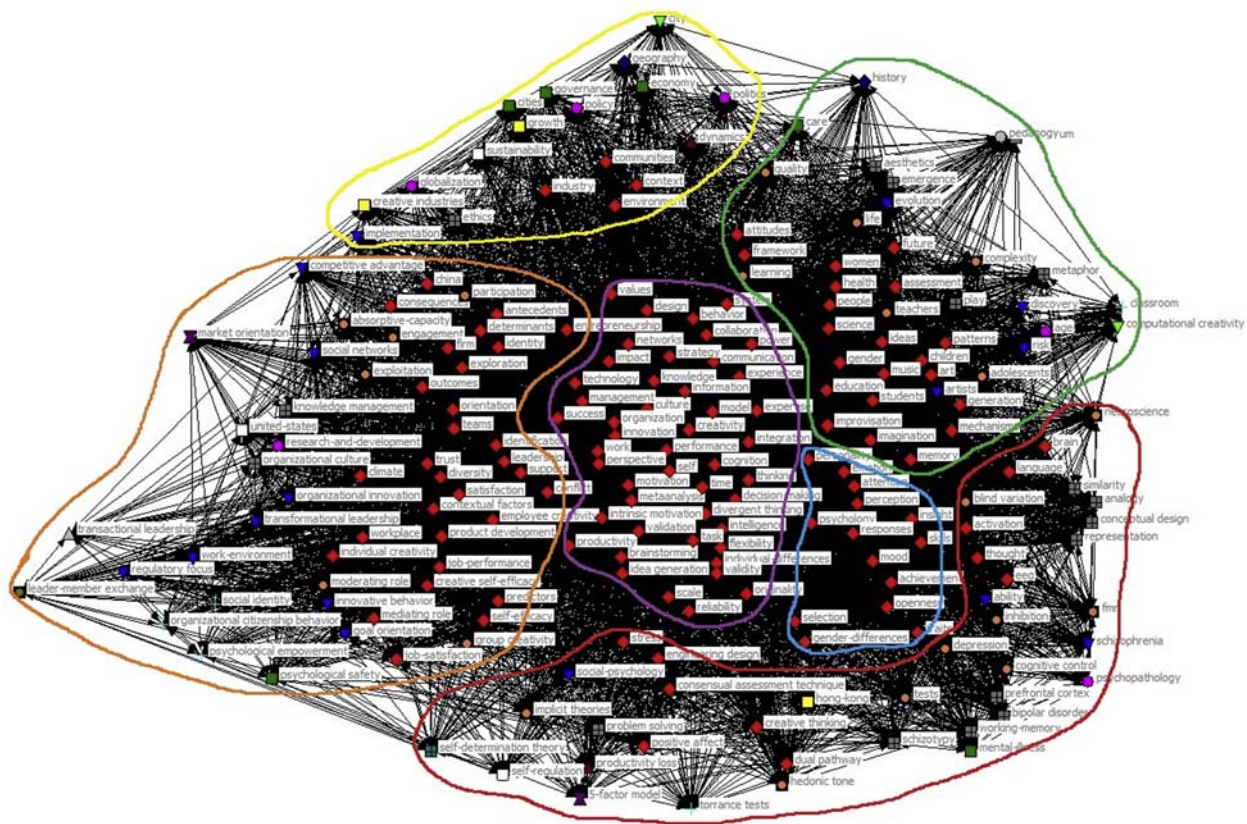


Figure 6 The results of K-core and MDS on keywords network of creativity research. Note: Red diamonds, Orange circles, Blue Down Triangles, Gray boxes, Crimson Up Triangles, Yellow squares, Purple circles, Green squares, White squares, Things, Pluses, Dark blue diamonds, Circle-in-Box, Cyan Down Triangles, Green Boxes, Gray Up Triangles, Gray square and Gray circles respectively represent keywords with 54, 53, 52, 51, 50, 49, 48, 46, 44, 42, 41, 40, 39, 38, 37, 35, 34 and 33 node degree.

considered macro-level factors within and outside the organizations (e.g., social network, pro-creativity policies) related to creativity in a broad sense. Furthermore, at the bottom of the map is a long, flat circle composed of keywords representing studies that explore and extend theories on creativity. In contrast, the keywords concentrated in the top circle may come from research applying creativity theories and frameworks in different areas.

Specific Research Paradigms

As to the conceptualization of creativity, albeit some variation in scholars' understanding of what essential elements comprise creativity (e.g., Dean et al. 2006; Durand and Van Huss, 1992), the most widely adopted is Amabile's (1983, 1996) definition that creativity is the generation of novel and useful ideas in a particular domain. Accordingly, her componential model of creativity (1983), which encompasses three components of motivation, expertise, and creative thinking skills, has laid foundation for subsequent research on individual creativity (e.g., Zhang and Bartol, 2010). Additionally, recognizing joint influence of individual characteristics and situations, the interactionist approach to creativity has also been adopted in examining creative processes and performance (e.g., Zhou and George, 2001), particularly in the domains that appreciate contextual impacts (e.g., organization studies).

A vastly different approach to understanding creativity has been focused on the biological sources of creativity. Research in physiology, pathology, and neuroscience has related creativity to human physiological and pathological conditions. For example, since Sperry's (1964) seminal work on human hemispheres' association with creativity, subsequent investigations have been conducted and integrated, which suggest that both hemispheres can be synergized to enhance creativity (e.g., Mashal et al., 2007). Furthermore, the association between creativity and psychopathological states has remained a topic of interest. Nettle (2006), for example, compared schizotypy profiles in a sample of poets, artists, mathematicians, psychiatric patients, and general population. He found that creative groups were featured by the absence of anhedonia and avolition. More interestingly, different domains required different cognitive profiles in fostering creativity, with poetry and art linked to divergent thinking, and schizophrenia, disorder, and mathematics to convergent thinking.

Similarly, creativity remains a research topic in the field of applied and social psychology. Research questions concern individual cognitive styles (e.g., Torrance Tests of Creative Thinking, Kim, 2006; self-regulation, De Stobbeleir et al., 2011), affect and mood

(e.g., positive affect, Fritz and Sonnentag, 2009), stress (e.g., occupational stress, Van Dyne et al., 2002), personality (e.g., five-factor model, Dollinger et al., 2004), and so on. An example of these is studies examining the relationship between affect and creativity. Scholars have theorized and found that creativity can be associated with both positive and negative mood (e.g., George and Zhou, 2007; Nijstad et al., 2010), and emotionally ambivalent state has been linked to recognizing of unusual associations between concepts in experimental settings (Fong, 2006). At the organizational level, the linkage between positive affect and creativity has also been validated in entrepreneurs and related to organizational innovation (Baron and Tang, 2011).

Most of creativity research to date have been conducted at the individual level. These studies explored the components and antecedents of individual creativity and revealed the influence mechanism of the antecedents. Since Amabile (1983, 1996) put forward the principal component theory of individual creativity, many scholars have carried out exploratory research around motivation (Mueller and Kamdar, 2011; Dewett, 2007; Eisenberger and Shanock, 2003; Zhang and Bartol, 2010), expertise (Helie and Sun, 2010; Kaufman et al., 2009; Scott et al., 2005; Taggar, 2002; Vincent et al., 2002), and creativity skill (Runco et al., 2010; Cropley, 2006; Jung et al., 2010; Kim, 2006; Runco and Acar, 2012; Vincent et al., 2002), which were the foundation of other creative research and located at the center of the keywords network.

Furthermore, personality is a person's stable attitude toward reality, and traits expressed in the habitual behavioral patterns corresponding to the attitude. Personality has been linked to individual creativity (Mumford, 2003; Madjar et al., 2002; Taggar, 2002; Zhou, 2003). In the "Big Five" personality model, openness to experience is considered as the most relevant to creativity (Schilpzand et al., 2011). George and Zhou (2001) adopted an interactional approach to understanding how openness to experience and conscientiousness were related to creative behavior in the workplace. They proposed that openness to experience will result in high levels of creative behavior and conscientiousness in low levels of creative behavior, when the situation activates these traits. Baer and Oldham (2006) examined the possibility of a curvilinear relation between the creative time pressure employees experience at work and their creativity. The authors also examined whether the curvilinear relation between the creative time pressure and employees' creativity was moderated by employees' scores on the openness to experience personality dimension. Other factors linked to individual creativity include emotion (Fong, 2006; van Kleef et al., 2010; Akinola and Mendes, 2008; Ivcevic et al., 2007; Newton, 2013), mood (Lewis and Lovatt, 2013; Rybakowski and Klonowska, 2011), attention (Kharkhurin, 2011; Memmert, 2006), perception (Zenasni and Lubart, 2009; Forgeard, 2013), attitudes (Lee and Erdogan, 2007; Crilly, 2015), gender difference (Matud et al., 2007; Lau and Cheung, 2010; Niu and Liu, 2009), etc.

Perhaps the most rapidly growing area of research in creativity is in the field of organization and management. Keywords extracted from the database indicate two approaches based on which management scholars study creativity in organizations. First, substantial attention has been devoted to creative behaviors and processes in the organizational context. For example, considering the collaborative nature of organizations, researchers examining creativity in organizations have focused on collective processes that lead to team creativity and innovation, with focal variables such as team diversity (Bell et al., 2011), team identity (Sethi et al., 2001; Liden et al., 2014), team reflections (Somech, 2006; Hargadon and Bechky, 2006), team norms (Jiang and Chen, 2018), etc. Among these a well-developed construct linking to team creativity and innovation is team climate (West, 2002). A climate for performance excellence and one for participative safety have been found to correlate with team innovation (see Hülshager et al., 2009 for a recent meta-analysis).

Further, studies addressing organization-level creativity have attended to more macro-level factors such as marketing strategy (Kropp et al., 2006; Golovko and Valentini, 2011), industry conditions (Bisson et al., 2002), corporate strategy (Volberda et al., 2001; Chesbrough and Appleyard, 2007), firm capability (Nonaka and Toyama, 2002; Ganesan et al., 2005), entrepreneurial activities (Tang et al., 2012; Lee et al., 2004), and human resource management practices (Beugelsdijk, 2008; Chang et al., 2011). Given that research and development (R&D) units or groups are the primary innovation powerhouse in organizations, numerous studies have been conducted in examining creativity of R&D personnel or groups (e.g., Tierney and Farmer, 2004; Hirst et al., 2009; Miron et al., 2004). Moreover, creativity and performance processes by R&D organizations are illuminated with a knowledge management perspective that highlights enabling knowledge flow and access to tacit knowledge (Jackson et al., 2006).

A contextual factor identified as a major driver of creativity in organizations is leadership (Shalley and Gilson, 2004), which has been associated with creativity at multiple levels. In particular, individual creativity has been linked to such leadership styles/behaviors as empowering leadership (Zhang and Bartol, 2010), transformational leadership (Gong et al., 2009; Shin and Zhou, 2003; Hirst et al., 2009), servant leadership (Liden et al., 2014), leader-member exchange (Volmer et al., 2012), and leader supportive behavior for creativity (Amabile et al., 2004). At the team level, team creativity and innovation were found to be related to empowering leadership (Chen et al., 2011) and transformational leadership (Eisenbeiss et al., 2008; Jiang and Chen, 2018; Shin and Zhou, 2007). Finally, organization-level creativity and innovation have been examined as an outcome of transformational leadership (Jung et al., 2003; Gumusluoglu and Ilsev, 2009), visionary leadership (Strange and Mumford, 2005), ambidextrous leader behaviors (Rosing et al., 2011), complexity leadership (Uhl-Bien et al., 2007), etc. Among various leadership theories, transformational leadership appears to be the most studied in creativity and innovation research across levels. Findings generally supported its positive effects on creative behaviors and performance (e.g., Jiang and Chen, 2018; Jung et al., 2003; Shin and Zhou, 2003).

Besides leadership, another frequently studied variable in creativity and innovation research is social network. Originating from sociology, this line of thought views social structure as important for creativity, but is divided in its relative creative benefits of two opposing types of collaborative network structure: cohesion (e.g., social capital, Coleman, 1988), with actors connecting directly to each other, and brokerage (e.g., the strength of weak, diverse ties, Granovetter, 1973), with a few actors linking others who have no direct ties to each other. Likewise, most social network scholars have addressed creativity issues following the two logics, with both

cohesion (e.g., Obstfeld, 2005; Milliken et al., 2003; Uzzi and Spiro, 2005) and brokerage (e.g., Perry-Smith, 2006; Burt, 2004) perspectives having received some support.

More recent studies began to develop more complex relationships, as well as to integrate the two competing hypotheses. Lingo and O'Mahony (2010) resolved the question of how brokers generate creativity, finding that the answer lies in the integration of ideas of other collaborators by brokers through the processes of dealing with different types of ambiguities. Zhou and colleagues reported a curvilinear effect of weak ties on greater creativity, revealing a diminishing return on the number of weak ties (Zhou et al., 2009). Reconciling the cohesion and brokerage camps, Fleming et al. (2007) demonstrated the benefits of both, with brokerage leading to collaborative creativity and cohesion adding marginal benefits in conjunction with broad personal experience and external ties. Further, these authors found that cohesive networks were associated with the future use of creativity. In fact, the value of cohesive networks in the later stages of the idea journey (Perry-Smith and Mannucci, 2017), that is, after idea has been generated, has been confirmed in recent studies (e.g., Kijkuit and van den Ende, 2007; Baer, 2012).

Studies of creativity in the field of economic and urban geography have centered on the question of whether and how creativity contributes to economic growth and regional development. Departing from previous view that highly educated people are the primary determinant of local economic performance, Florida (2002) defined the creative class, formed by people who contribute to the economy by identifying problems, generating novel ideas, developing new technology, and recombining knowledge in new ways in attempt to find original solutions. In particular, these people are employed in such occupations as science, engineering, culture, arts, and entertainment. Florida claimed that it is the creative class, rather than the highly educated group, makes the most contribution to urban and regional growth. The past two decades witnessed continued advances in understanding the impact of creative class (e.g., Clifton, 2008), creative industries (Lange et al., 2008; Christophers, 2007; Stam et al., 2008), creative policies (Boren and Young, 2013), and creative economy (Wilson, 2010). A general consensus is that creativity, interplaying with cultural and ethnic diversity at multiple levels (Baycan-Levent, 2010), contributes to innovation, the development of high-technology industries, and economic growth. For example, a study of 257 regions of European Union reported that highly educated people in creative occupations contributed most to production efficiency (Marrocu and Paci, 2012). Another study of 444 city regions in eight European countries found that the creative class' specialized consumer preferences and job preferences jointly influenced the creative urban hierarchy, due to lower market thresholds for creative services and jobs (Lorenzen and Andersen, 2009).

From the perspective of social relationships, various factors are linked to creativity and innovation in contemporary urbanization processes (Scott, 2014). In a research on the primary metropolitan statistical areas in the US, density of creative workers was found to predict metropolitan patenting activity, supporting knowledge spillovers as key to boosting innovation. On the other hand, a study of Berlin's creative industries revealed a dynamic, self-governing pattern that deals with paradoxes of creativity by, for instance, communities of practice and the "culturepreneur" (Lange et al., 2008). Further, using provincial level data of mainland China, Qian (2010) reported the ratio of university students to local population to be the single most important predictor of the creative class in China. Overall, the majority of research was conducted in North America and Europe, with only a handful of studies focused on developing nations such as China (e.g., Qian, 2010).

Research on creativity also attracts scholars from basic disciplines of humanities and social science. For instance, pedagogical studies have explored various ways of learning experiences and pedagogical practices that may foster children and students' creativity. Craft and colleagues, for example, stress the importance of promoting creative learning and suggest approaches teachers can adopt to foster creativity in young learners (Chappell et al., 2009; Cremin et al., 2006). Further, Creativity is viewed as an outcome of play and learning (Samuelsson and Carlsson, 2008; Kangas, 2010). Finally, researchers have also examined assessment technique for creativity (e.g., consensual assessment of creativity) based on student writings (Kaufman et al., 2004).

In the field of arts, scholars have investigated the associations between creativity and improvisation (e.g., Montuori, 2003), imagination (e.g., Hargreaves, 2012), problem solving (Kozbelt, 2008), personality traits (e.g., openness to experience, Kaufman et al., 2016), etc. Creativity ratings have been found to vary between artist raters and non-artist raters (Serafin et al., 2011). Creativity-relevant cognitive styles (e.g., divergent thinking, Gibson et al., 2009) have been reported to differ between creative individuals (trained musicians) and general population. On the other hand, in the fields of public health, a creativity-support environment is not only conducive to employee productivity and quality (Dul and Ceylan, 2011, 2014), but also to health and well-being (Greaves and Farbus, 2006). As to creativity in scientists, Azoulay et al. (2011) compared investigators of the Howard Hughes Medical Institute (HHMI) with grantees from the National Institutes of Health (NIH); they found that HHMI investigators produced high-impact articles more likely than NIH-funded scientists. The authors ascribed the differences to HHMI's tolerance of early failure, focus on long-term success, and support of experiment. Finally, gender difference in creativity has drawn much research interest as well, with direct comparison between genders in creative tasks and performance (Kaufman et al., 2004) or testing of gender as moderating the effects of education (Ross and Mirowsky, 2006), positive affect (Filipowicz, 2006), and leadership styles (Wang et al., 2013). Studies have also examined women's creativity in terms of, for example, their diverse creative efforts and productivity (Reis, 2002).

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Testing/Masurement/Assessment[☆]

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Glossary

- Conceptual definition** The definition of an abstract construct using other abstract constructs
- Convergent thinking** Cognitive processes that result in one or a few responses to a question or stimulus
- Divergent thinking** Cognitive processes that result in numerous ideas in response to a question or stimulus
- Histriometrics** The application of quantitative analysis to data concerning historical figures
- Operational definition** The definition of an abstract construct in observable, measureable terms
- Psychometrics** The quantitative analysis of psychological measurement characteristics
- Reliability** The extent to which test scores show consistency
- Validity** The extent to which inferences drawn from test scores are appropriate for their use

Why Assess Creativity?

Creativity is a fundamental human characteristic. Evidence of creativity is apparent across time and across cultures, from ancient civilizations to 21st century endeavors. It is displayed at the individual level as well as in collaborative enterprises. The effects can be found in small ideas as well as in revolutionary advances. Creativity's contributions to all areas of human activity, including science and technology, medicine, government, agriculture, literature, the arts, and entertainment are undeniable. There is no doubt that creativity enriches and enhances human life.

Because of the breadth and depth of its impact, understanding and capturing creativity is of great interest. In order to systematically study creativity, however, one must have a means of assessing it. Assessment simply refers to the evaluation of the quality or quantity of a construct. Assessment may be based on one or more measures, or methods of measuring, or quantifying, the construct. Testing, a special case of measurement, refers to the use of standardized procedures for quantification of a construct.

Numerous techniques have been developed to assess creativity in individuals, groups, and organizations. Creativity measures are generally used to identify creative potential, to examine and understand factors that relate to creative performance, or to determine the impact of creativity interventions. The popularity and diversity of creativity assessment techniques illustrates the desire to grasp the valuable resource that is creativity.

[☆] *Change History:* August 2019: Mark Runco updated this chapter by streamlining and clarifying. Morris Stein is now cited on the different of subjective and objective frames of reference. Discussion of the 4P framework was clarified and the "potential" category (a 5th P) is now included. Discussion of Big C creativity was omitted because of discussions that it is misleading and part of a false dichotomy. The concepts "eminent" and "everyday" creativity are much more useful and thus used herein. The value of contraindicative items in personality measures is briefly described. This article is an update of M.M. Clapham, Testing/Masurement/Assessment, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 458–464.

Is Creativity Assessment Useful?

Creativity is a broadly used term. Sometimes it is used to specify a personal characteristic, such as when an individual is described as having high levels of creativity. On other occasions, it is used as a descriptor of objects or ideas, as is the case when opinions about the level of creativity displayed in artwork are offered. Yet in other applications it refers to a cognitive process, such as when a person is encouraged to use creativity in developing a solution to a problem. Although the term has varied applications, there is a shared sense of its general meaning: creativity involves producing something new and different, but also something that is effective or has value.

The meaning of creativity sometimes evokes skepticism about the possibility of assessing it. How can something that is unknown be measured? Is it possible to understand an outcome that is unforeseeable? Although the assessment of creativity may seem paradoxical, there are tests that lead to accurate predictions. This entry highlights many successful efforts to assess particular aspects of creativity, or at least creative potential, and to predict actual creative performance with reasonable accuracy. The assessment of creativity is feasible and, given the importance of creativity for individuals, society, and culture, it is critical to understanding human nature.

Defining the Construct

As with any abstract construct, a definition must first be established in order for assessment to take place. Most researchers in the field identify creativity as an ability or capacity to produce objects or ideas that are novel and purposeful. These are the two components of the standard definition. The first component is widely accepted. Most people identify creativity with originality. The second component, however, is more controversial. Why must something be appropriate or useful in order to be considered creative? Is it not the case that many creative works were deemed highly inappropriate by society at the time of inception? Creativity scholars interpret “appropriateness” and “usefulness” in the broadest sense. The original idea should have intent, purpose, meaning, in order to be creative. A unique random thought produced by an individual is generally not considered creative unless it is developed or applied with some intent or purpose. The nature of this intent may vary widely. It may consist of solving a practical problem or developing a coherent theoretical model. But it may also consist of expressing an emotional state for oneself or for others, in provoking an emotional reaction, or in presenting an alternative perspective or method. A dream you have may be very unique, so much so that you share it with friends and family who proceed to describe it as “really weird” or “bizarre,” yet this dream is not generally described as demonstrating creativity. Implementing ideas that are gathered from your dreams, however, may be associated with creativity.

This definition of creativity remains in flux. According to the standard definition, creativity is context dependent. To identify something as original, one must establish a point of comparison. Is it original in relation to the entire history of humanity? Is it original in comparison to the typical work produced by members of a certain age group within a specific culture? Or is it original within one person, a new idea for a particular individual?

To determine appropriateness, one must also consider context. Is the idea or artifact appropriate given the situation in which it was produced? Would creative works from past centuries be considered equally provocative or ingenious if they had been produced for the first time today? Morris Stein referred to the various comparisons as objective (when creative things are compared against societal norms) and subjective (when creative things are compared to the individual’s own history).

Definitions of creativity must be operational, in a scientific sense, or expressed in observable terms, in order to be useful for creativity assessment techniques. Both the purpose of assessment and the theoretical perspective of the researcher affect how a construct is operationalized. Assessing creative potential in children, for example, requires a different measurement approach than evaluating the creative contributions of eminent historical figures. Not surprisingly, a wide array of measurement techniques have been developed.

Historical Foundations

Until relatively recently, creativity was not scientifically studied. Explanations of creative outcomes, if given at all, frequently referred to supernatural influences such as muses, divine intervention and demonic powers, or to vaguely identified personal characteristics such as “giftedness” and “madness.” Many believed these external or internal forces in turn produced an “a-ha” experience in individuals that in turn propelled them to act on their ideas.

As the study of individual differences in psychological characteristics gained importance in the late 1800s and early 1900s, greater attention was directed toward the construct of creativity. Initial steps toward assessing creativity began with experimental attempts to measure fluency and imagination. Stimuli such as inkblots or word association tasks were used to assess these constructs. At this time, investigators considered creativity to be either a component of general intellectual functioning or a characteristic of personality.

J. P. Guilford is credited with directing greater attention to the scientific study of creativity and providing a framework in which to do it. His 1949 presidential address to the American Psychological Association (published in 1950) emphasized the need for psychologists to dedicate more time and effort to understanding creativity. He developed a multidimensional model

of intellect, called the structure of the intellect (SOI), that classified mental abilities by operation performed, content used to perform the operation, and the type of product produced. The broadest impact of this model was the distinction between two types of operations, convergent thinking, associated with traditional forms of intelligence, and divergent thinking, associated with creativity. Convergent thinking refers to a mental process that focuses an individual on one correct response. Divergent thinking, in contrast, is a mental process that results in a wide range of potential responses. Guilford and his colleagues identified several primary components of divergent thinking. These included fluency, flexibility, and originality. Fluency is the number of interpretable ideas produced in response to a stimulus. Flexibility refers to the number of different categories of ideas produced. Originality is the uniqueness of the ideas. Guilford and his associates designed measures to assess these components of divergent thinking.

Guilford was instrumental in popularizing both the construct and means of measuring it. Guilford believed divergent thinking was a distinguishing feature of creativity, and most current theories of creativity consider divergent thinking to be a necessary, although not sufficient, requirement for creativity. Furthermore, Guilford's conceptualization of divergent thinking influenced the development of a popular method of assessing creativity, divergent thinking tests. The divergent thinking tests developed by Paul Torrance, not long after Guilford's presidential address, continue to be some of the most widely used creativity tests worldwide, and there are several other newer batteries (e.g., the rCAB, Williams test).

Guilford's call for more research on creativity not only impacted the study of creativity as a cognitive process. His work also stimulated researchers to study creativity as it relates to personality. Of particular importance was the work conducted by researchers at the Institute of Personality Assessment and Research at the University of California in Berkeley. Both Frank Barron and Donald MacKinnon are noted for providing important insights into the characteristics of creative achievers. Their research influenced the use of personality measures as well as ratings of creative achievements for the assessment of creativity.

Since the mid twentieth century, researchers have made significant strides in the study of creativity. Numerous useful measures of creativity have been developed as a result of this research that serve, in turn, as tools for furthering our understanding of creativity. More research in this area, however, is warranted. Although great progress has been made, the scientific study of creativity remains limited relative to the importance of this construct.

Foci of Creativity Assessment

Creativity assessment tends to follow the well-known 4P framework. Thus assessments, like theories of creativity, can be grouped into four broad categories: products, people, processes, and environmental press. "Potential" has been recently added to the 4Ps and there are tests that do indeed focus on creative potential. Each of these categories necessitates that assessment efforts have a different focus. In measuring products, the emphasis is on specifying the level of creativity displayed in objects or ideas. In order to do so, type of product should be considered. Inventions, for example, may best be assessed using different methods than those applied to the evaluation of artwork. In assessing creative people, the interest is in identifying attributes associated with creative individuals. In this case, consideration must be given to the population of interest. Methods for evaluating creativity in children may differ from those for adults. In assessing processes, the researcher focuses on the cognitive functions involved during the varied stages of creativity. Divergent thinking tests offer information about relevant processes, though they also fit into the creative potential category. With environmental and press (or creative places), the interest is in determining the environmental conditions that, when pressed upon a person, enhance or inhibit creativity.

The distinction made between eminent creativity and everyday creativity is also useful. Eminent creativity is displayed by individuals of renowned fame who are recognized as creative geniuses. Figures such as Einstein, Beethoven, Cezanne, and Galileo, represent eminent creativity. In contrast, everyday creativity, is displayed in creative endeavors that have less breadth or depth of impact on society. Everyday creativity may present itself at a personal level, in original and useful responses within the range of responses typical for a particular individual, or at a social level, in original and useful responses relative to those produced within a socio-cultural group. It may consist of the development of completely new ideas or the adaptation of existing objects to meet new demands. Examples of everyday creativity include original artwork produced by children, unique dance moves that become the popular trend, or small adaptations of objects to meet current demands.

These two types of creativity, eminent and everyday, are studied using different methods. Eminent creativity is most commonly examined through case studies or historiometrics. Case studies generally produce qualitative descriptions of individuals, while historiometrics involves the quantification of information related to historical figures. Eminent creativity is interpreted as representing the highest level of achievable creative performance. It can serve as a standard to which all other creativity is compared. Its study, however, is limited by what information is available in historical records and how this information is used. The study of everyday creativity generally examines creativity of the present, which allows for the use of a broader array of assessment methods. It also relies on assessment of creativity in a relative rather than absolute fashion. In so doing, the creativity of a participant may be compared to that of others, or to one's own under different conditions, instead of to an absolute level of creativity. This relative approach to assessment acknowledges the importance of context for creativity.

The varied points of focus in creativity assessment give the sense that creativity researchers are very scattered in their study of creativity. At the same time, the availability of creativity assessment techniques that have varied points of focus provides an opportunity to examine creativity from different perspectives.

Types of Creativity Measures

Creativity measures can be classified based on their aim and content. According to a popular taxonomy presented by Dennis Hocevar and Patricia Bachelor, the primary types of creativity measures are: divergent thinking tests; attitude and interest inventories; biographical inventories; personality inventories; ratings by peers, teachers, or supervisors; ratings of eminence; judgments of products; and self-reported creative activities. A variation of this taxonomy with an added category, environmental climate inventories, is used below as a framework for discussing types of creativity tests.

Divergent Thinking Tests

Divergent thinking tests are arguably the most frequently used approach for assessing everyday creativity and creative potential. They are reliable estimates of potential in the sense that they tap originality, but they do so using open ended tasks or tests. Like all tests, they are, then, samples of behavior but not entirely representative of the entire universe of relevant capacities. As a matter of fact all tests are samples and thus estimates of potential or of future performance.

Divergent thinking tests ask participants to produce multiple ideas in response to specific stimuli. Stimuli and responses are typically either pictorial or verbal in nature. Examples of item response formats include drawing pictures using an incomplete figure, writing questions evoked by hypothetical situations, or listing possible uses for an object. The intent is to measure divergent thinking skills displayed in examinee responses. Divergent thinking tests usually assess multiple skills, as noted above, including fluency, flexibility, originality, and elaboration. Some have been used to get at problem generation skills and not just problem solving, and others have been scored for indices in the direction of effectiveness and appropriateness (Runco and Charles, 1993).

Many divergent thinking measures are available. Some of them are considered general tests that can be administered to a broad segment of the population. These include the *Torrance Tests of Creative Thinking (TTCT)*, the *Alternative Uses or Consequences* tests, *Many Titles*, *Problem Generation*, and *Realistic tests* in the Runco Creativity Assessment Battery (rCAB), and international instruments such as the Spanish *CREA* test. Other divergent thinking tests were designed with stimuli that apply to specialized fields of expertise, as is the case with the *Purdue Creativity Test* for engineers and the *Creative Engineering Design Assessment (CEDA)*. Some measures assess both divergent and convergent thinking. The *Structure of the Intellect Learning Abilities Test (SOI-LA)* is an example of such an instrument designed for the general population.

Evidence supports the contention that divergent thinking tests measure a construct that is distinct from that measured by traditional academic aptitude tests. Validity studies show that overall scores are related to creativity as measured by expert evaluations of performance as well as by creative achievements. Studies examining the ability of divergent thinking tests to predict creative performance in the long term demonstrate weaker associations than those examining associations between divergent thinking and creative performance in the present. Critics of the tests argue that their ability to predict future creative performance is limited, but predictive validity coefficients are often as higher than those from IQ tests or commonly used personality inventories.

A number of studies found that scores on different types of divergent thinking tasks, such as verbal, figural, or mathematical, do not show strong associations with each other, suggesting that domain specific skills influence test performance. The basis for this finding may lie in the fact that divergent thinking tasks require additional skills beyond divergent thinking that are linked to domain expertise, rather than in the notion that the process of divergent thinking itself is domain specific. Regardless of the reason, it appears that divergent thinking tests containing different types of stimuli and response formats are not completely interchangeable.

Overall, despite some limitations, research on divergent thinking tests indicates that they can be useful in measuring an important component of creativity, divergent thinking.

Self-assessment Inventories

Some creativity self-assessment inventories focus on characteristics of the person rather than on thinking skills demonstrated in the production of a response. Their purpose is often to tap into one's personal orientation toward creativity. There are several types of self-assessment inventories, including attitude and interest questionnaires, biographical inventories, and personality measures.

Attitude and interest inventories are based on the belief that creative individuals tend to have attitudes and interests that distinguish them from less creative individuals, such as positive inclinations toward taking risks, trying new activities, engaging in hobbies that allow exploration or self-expression, or being playful. Questions in these inventories may consist of rating scales, forced-choice options, or checklists. Examples of such inventories abound. The *Creative Attitude Survey* assesses characteristics such as imagination, creative interests, humor, and risk-taking in children. Appropriate questionnaires for adults are also available, such as the *How Do You Think?* And the *How Creative Are You?* The *Khatena-Torrance Creative Perception Inventory* has two subtests: *Something About Myself* focuses on interests and *What Kind of Person Are You?* Assesses personality characteristics. The *Creative Styles Questionnaire-Revised* integrates elements of interest and personality into one measure in an effort to assess thinking style that relates to creativity. Consistent with theories of style the focus is on "how" rather than "how much."

Biographical inventories for creativity collect information on individuals' activities and experiences that are believed to be associated with creative performance. These inventories include questions on topics such as current and past hobbies, leisure activities, family history, childhood environment, and educational experiences. In addition to questions that are biographical in nature, these

inventories sometimes include items related to interests and attitudes. The item format is usually a frequency rating scale or a checklist. Biographical inventories, such as those developed by Schaefer (the Biographical Inventory of Creativity, or BIC) or Batey, may be general or domain specific. Other inventories, based on evidence of differences in the backgrounds of creative individuals from diverse fields, are designed to apply to specific areas of expertise. The *ALPHA Biographical Inventory* from the Institute for Behavioral Research in Creativity, for example, was designed for scientists.

Interest/attitude inventories and biographical questionnaires have strengths and weaknesses. They are relatively easy to administer, and research shows that they generally have adequate reliability. Studies comparing the two types of tests indicate that interest/attitude inventories and biographical inventories are highly interrelated. This is not surprising for several reasons. First, to the extent that individuals have choices about activities, interests can affect activities. Second, as stated earlier, biographical inventories may contain interest items, and interest inventories may contain biographical items, thus blurring the distinction between the measures. These inventories, however, provide distinct information from that obtained by divergent thinking tests as indicated by relatively low associations between scores on the two types of measures. Validity studies generally provide some support for the use of interests, attitudes, and biographical information in evaluating creative potential. Some specific inventories, however, provide limited evidence of validity. Further examination of the validity of these inventories is warranted.

Personality inventories assess an individual's typical pattern of responding to situations. The characteristics assessed may be defined as personality traits or types. Most personality inventories studied in relation to creativity are questionnaires that assess an array of personality dimensions, some of which are believed to be related to creative performance. Examples of these inventories include Cattell's *16 Personality Factor Questionnaire* (16PF) and the *NEO Personality Inventory* (NEO P-RI). The *Creative Personality Scale* from the *Adjective Check List* is an example of a creativity scale that was developed from a personality inventory. Other inventories are specifically designed to assess the creative personality, as is the case with the *Cree Questionnaire*. The California Psychological Inventory now has a creativity subscale, and several measures, such as the "How Would You Describe Yourself" of the rCAB is a stand-alone survey which contains only items indicative of the creative personality. More precisely all items reflect creative personality traits, but some are worded in the negative direction (e.g., "to what degree are you a conformist?"). Such inclusion of indicative and contraindicative questions makes it unlikely that individuals will respond to all items the same way. In Psychometric terms, they minimize the chance of response sets.

A very commonly used survey focuses on the *NEO PI-R* characteristics of extraversion, emotional stability, openness to experience, conscientiousness, and agreeableness, commonly referred to as the Big 5. Much research has been conducted on the relation between these characteristics and creativity. Openness seems to be especially clearly tied to creativity.

Evidence is somewhat inconsistent, but patterns of relationships have emerged that suggest differences in personality characteristics associated with creativity in various domains. Openness to experience is, as just noted, broadly relevant, but extraversion has been found to relate positively to performance on divergent thinking tasks and in creative occupations that require social interaction. Conscientiousness appears to show a positive association with scientific creativity but not artistic creativity. Emotional instability, in contrast, has been found to be positively associated with artistic creativity. The Big 5 dimensions are very broadly defined, which limits the ability to specify aspects of personality that relate to creativity with precision. Subcomponents of the *NEO PI-R* measures as well as alternative measures, such as the dimensions of the *16PF*, have been used to examine the relationship of more narrowly defined personality characteristics to creativity. The *16PF* characteristics of persistent, adventurous, imaginative, shrewd, and self-sufficient have been related to creativity. Continued research should clarify how personality characteristics interact with domains of creative pursuit.

Self-reported Creative Activities

Self-reported assessments of creative activities focus on past activities and accomplishments. They are distinct in that they aim to specify the quantity and/or quality of creative activities, rather than personal experiences that are associated with creative performance. In other words, the focus is on the product rather than the person. Quality scores tap socially recognized creative achievements. Hocevar and Bachelor concluded that this sort of measure may be best.

These assessments usually produce counts or frequencies of real-life accomplishments believed to reflect creativity. In some applications, the accomplishments may be ranked or rated by quality, though that does bring subjectivity into play. Writing plays, stories or musical pieces; publishing research articles; being selected for art show participation, receiving special awards and recognitions for original contributions; and obtaining patents for inventions are all examples of creative accomplishments. Most of these inventories for assessing creative activities are modifications of Holland's original *Creative Activities Checklist*, from the 1960s. Newer versions include Hocevar's *Creative Behavior Inventory*, the Creative Activity and Accomplishment (from the rCAB), the Inventory of Creative Activities and Achievements (ICAAs), and the *Creative Achievement Questionnaire* (CAQ). Another inventory, the *Runco Ideational Behavior Scale* (RIBS), assesses self-rated level of engagement in ideational activity rather than actual creative accomplishments. The assumption of the RIBS is that ideas are the products of creative processes. Several investigations have found the RIBS to be a useful criterion in research on the predictive validity of divergent thinking tests. Further research on this inventory to examine its relation to other types of measures is warranted.

Self-reported creative activity measures are valuable as criteria, or standards, to which other creativity assessment instruments are compared. For example, research showing that divergent thinking tests are able to predict significant creative accomplishments provides validity for the use of divergent thinking tests as indicators of creative potential. Creative activity measures show strong

reliability in overall scores. Difficulties in their use derive from the fact that substantial creative accomplishments are limited in number for most people, making it difficult to determine distinctions in creativity, while involvement in activities may relate more strongly to interests than accomplishments. Just as it is important to keep in mind that different measures aim at process, product, personality, place, or potential, so too is it useful to keep in mind that some measures (e.g., divergent thinking or personality) are predictors, while others (the RIBS, or Holland's Creative Activity Check list) are criterion measures. This distinction was offered by Michael Wallach in 1970s but still applies today.

Ratings/Rankings/Nominations of People

In this form of assessment, a knowledgeable individual reports on other people's creativity. In the case of eminent creativity, the evaluator is usually considered an expert in a specialized field and is asked to either nominate individuals within that field whom they consider to have made important creative contributions, or alternatively to rate or rank the creative contributions of individuals in a provided list. In the case of everyday creativity, the evaluator is most typically a peer, teacher, or supervisor who knows the person well. This evaluator may be asked to provide a global rating of an individual's creativity or to rate the person on several dimensions related to creativity. The *Meeker Creativity Rating Scale* and the *Teachers' Evaluation of Students' Creativity (TESC)* were developed to rate students on creativity-related characteristics, while the *Parental Evaluation of Children's Creativity (PECC)* asks parents to assess their children's idea generation. Teacher, peer and supervisor ratings, rankings and nominations have been used as criteria for evaluating the validity of creativity tests and the effectiveness of creativity interventions. Research shows that multiple evaluators with knowledge of an individual and information on the rating criteria provide similar creativity ratings. Some critics, however, question the level of validity of these assessments. Whenever judges are involved, there is subjectivity which creates the possibility of halo effects or systematic bias. The key concern is that of generalization. Certain groups of judges may give reliable ratings but this does not mean that what they think (i.e., their ratings) will generalize to all groups of judges.

Judgments of Products

Some of these same concerns apply to ratings of creative products. In this assessment approach, knowledgeable individuals rate ideas or artifacts on their level of creativity. One or several questions may be used in the rating scale. The most popular and sound method for rating creative outcomes is the *Consensual Assessment Technique*. In this method, multiple expert judges rate the creativity of an observable response within a particular domain. Artists rate paintings or collages, writers rate stories, mathematicians rate math problems, and so on. The average rating across experts is then used as the measure of creativity. Experts are also asked to rate other dimensions of the product such as technical quality or attractiveness to ensure discrimination between dimensions. Research shows that this method generally results in high agreement among raters on creativity and clear distinction of creativity ratings from ratings on alternate dimensions. The consensual technique, with its use of multiple raters, reduces error due to idiosyncrasies of raters. Judgments of products using the consensual assessment method have been used effectively as criteria in many creativity studies.

Creative Climate Inventories

A relatively recent approach in creativity assessment is to examine the extent the environmental climate supports creativity. Several measures have emerged which assess factors in the environment that may promote or inhibit creative performance. The purpose of the *KEYS: Assessing Climate for Creativity* instrument is to assess stimulants and obstacles to creativity in work environments. Questions in the instrument ask employees to rate their work environment on a number of dimensions believed to relate to creative production. The instrument can be used by employees at various levels in the organization, and scores show strong evidence of association with ratings of organizational creativity. The *Team Climate Inventory (TCI)* is intended to assess climate for innovation in work teams. The instrument measures four dimensions of team performance: vision, participative safety, task orientation, and support for innovation. Tudor Rickards developed a measure that focuses on barriers within teams and organizations, which make sense because organizations can do things to support and inhibit creativity. Both should be assessed. Research to date indicates that these dimensions are related to perceived team performance on creative projects. These measures are an important contribution to the assessment of creativity (see [Table 1](#)).

Challenges and Opportunities

The various approaches to creativity assessment are quite distinct. Associations between scores on the diverse types of measures indicate that they are not assessing identical constructs. This poses challenges in the study of creativity.

First, choices need to be made in terms of appropriateness of measures for the intended purposes of assessment. Using an instrument for predicting creative potential is quite different from using a measure to evaluate current levels of creative performance or

Table 1 Partial list of creativity measures.

<i>Name of test</i>	<i>Authors/date</i>	<i>Type of test</i>
16 Personality Factor Questionnaire (16PF)	Cattell, R. B. (1993)	Personality
Abbreviated Torrance Test for Adults (ATTAs)	Goff, K. and Torrance, E. P. (2002)	Divergent Thinking
Adjective Checklist: Creative Personality Scale	Gough, H. and Heilbrun, A. (1965)	Personality
ALPHA Biographical Inventory	Institute for Behavioral Research in Creativity (1972)	Biographical
Alternative Uses	Christensen, P. R., Guilford, J. P., Merrifield, P. R., and Wilson, R. C. (1960)	Divergent Thinking
Biographical Inventory of Creativity	Schaefer, C. E. (1970), later Batey	Biographical
Consensual Assessment Technique	Amabile, T. (1982)	Judgment of Products
Consequences	Christensen, R. R., Merrifield, P. R., and Guilford, J. P. (1958)	Divergent Thinking
CREA	Corbalán, F. J., Martínez, F., Donolo, D., Alonso, C., Tejerina, M., and Limiñana, R. M. (2003)	Divergent Thinking
Creative Achievement Questionnaire (CAQ)	Carson, S., Peterson, J. B., and Higgins, D. M. (2005)	Activities/Accomplishments
Creative Activities Checklist (Holland, Hocevar)	Paek and Runco (2017)	Activities/Accomplishments
Creative Attitude Survey	Schaefer, C. E. and Bridges, C. I. (1970)	Interest/Attitude
Creative Behavior Inventory	Hocevar, D. (1979)	Activities/Accomplishments
Creative Engineering Design Assessment (CEDA)	Charyton, C., Jagacinski, R. J., and Merrill, J. A. (2008)	Divergent Thinking
Creative Styles Questionnaire-Revised	Kumar, V. K., Kemmler, D., and Holman, E. R. (1997)	Interest/Attitude/Personality
Cree Questionnaire	Thurstone, T. G. and Mellinger, J. (1986)	Personality
Group Inventory for Finding Interests (GIFFIs)	Davis, G. A. and Rimm, S. B. (1980)	Interest/Attitude
How Creative Are You?	Raudsepp, E. (1979)	Interest/Attitude
How Do You Think?	Davis, G. (1975)	Interest/Attitude
KEYS: Assessing Climate for Creativity	Amabile, T. M., Conti, R., Coon, H., Lazenby, J., and Herron, M. (1996)	Creative Climate
Khatena-Torrance Creative Perception Inventory	Khatena, J. and Torrence, E. P. (1998)	Interest/Attitude/Personality
Meeker Creativity Rating Scale	Meeker, M. (1987)	Ratings/Rankings/Nominations
NEO Personality Inventory (NEO PI-R)	Costa, P. T. and McCrae, R. R. (1992)	Personality
Parental Evaluation of Children's Creativity (PECC)	Runco, M. A. (1989)	Ratings/Rankings/Nominations
Purdue Creativity Test	Lawshe, C. H. and Harris, D. H. (1957)	Divergent Thinking
Runco Ideational Behavior Scale (RIBS)	Runco, M. A., Plucker, J. A., and Lim, W. (2001)	Activities/Accomplishments
Structure of the Intellect Learning Abilities Test (SOI-LA)	Meeker, M. and Meeker, R. (1975)	Divergent Thinking
Teachers' Evaluation of Students' Creativity (TESC)	Runco, M. A. (1987)	Ratings/Rankings/Nominations
Team Climate Inventory (TCI)	Anderson, N. and West, M. A. (1996)	Creative Climate
Torrance Test of Creative Thinking: Figural (TTCT-Figural)	Torrance, E. P. (1966)	Divergent Thinking
Torrance Test of Creative Thinking: Verbal (TTCT-Verbal)	Torrance, E. P. (1966)	Divergent Thinking

one that was designed as a criterion measure. A set of guidelines to assist creativity measurement users in the selection of instruments appropriate for their purposes would be quite practical.

Second, confusion can arise regarding what different assessment techniques actually measure. There is a tendency for the interpretation of the meaning of test scores to extend beyond their actual meaning. Divergent thinking, for example, is frequently equated with creativity when it more accurately represents just one component of creativity, ideation. Creativity interest inventories may be interpreted as instruments for identifying creative people when they assess relatively limited aspects of individuals that may relate to increased likelihood of creative performance. In either of these examples, additional conditions must exist for creativity to be displayed. The confusion about the meaning of scores can lead to erroneous inferences being drawn from research results.

Third, the identification of appropriate criteria for the study of creativity is difficult. Frequently used criteria include the RIBS, ratings of creative products, or scores on creative achievement and activity measures. As mentioned above, divergent thinking is occasionally used as a criterion but this is a mistake. The ideation displayed in these tests is produced within a testing condition that generally does not incorporate situational or motivational variables that affect creativity; performance on these tests does not mimic creative performance in real life. Tests of divergent thinking are predictors, or estimates of potential. Other potential criteria, such as ratings of creative products or counts of creative achievements pose their own problems. Obtaining meaningful ratings of creative products with high psychometric quality can be difficult and time consuming. Furthermore, the products that are rated may not be representative of one's creative capabilities across time and across domains. Similarly, measures of creative achievements may not be representative in that achievements might not be fully realized at the time of assessment. Using multiple criteria can compensate for limitations in any one assessment approach, and is therefore highly valued in research studies.

While challenges exist, the various approaches for assessing creativity also provide opportunities for integration of the creativity literature. Although there is some variability in the components specified by each of the available models of the creative process, they share basic elements. These include creative thinking skills, personal characteristics, and environmental factors that promote creativity. The tendency to study factors that influence these components individually prohibits a full understanding of the creative

process. There may be very complex interrelationships between the various factors involved in creativity and the diverse types of creativity. For this reason, studying one factor at a time using one measure of creativity may be misleading. Research using different types of creativity measures to assess the multiple aspects of creativity can illuminate the interrelationships between components of creativity. The variety of creativity measures that exist, therefore, comprise an important toolbox that can be used for integrating research findings into a coherent theoretical framework.

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Relevant Websites

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- <http://www.buffalostate.edu/creativity/> – International Center for Studies of Creativity.
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Theories of Creativity[☆]

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Introduction

For millennia, human beings have pondered the nature of creativity. Much of this speculation has served as commentary on the spectacular achievements of our species, with creators themselves often furnishing detailed descriptions of their own processes and motivations (Ghiselin, 1952). Until recently, theoretical conceptions of the nature of creativity have been rooted in first-person introspection or on case-study – like familiarity with the works of a small number of creators. However, in the last half century or so, scholars and researchers – mainly from psychology, but from other domains as well – have tried to advance on this armchair tradition (Kaufman and Sternberg, 2010; Runco, 2007; Sternberg, 1999). They have applied more rigorous research methodologies, increasingly sophisticated analytic techniques, far richer datasets, and (often) a pragmatic, applied orientation. Importantly, their approaches have also been informed by and grounded in knowledge from other relevant domains, including other sub-disciplines within psychology. The resulting surge of research activity has yielded a diverse array of theoretical approaches for understanding creativity. The purpose of this article is to describe contemporary theories of creativity and to offer a critical yet constructive appraisal of current theories and their promise for continued discovery about the nature of creativity.

Ways of Understanding Theories of Creativity

Pluralism

A generous-spirited way of understanding contemporary research on creativity is to emphasize *pluralism*, whereby a robust understanding is achieved through a multitude of perspectives, each characterized by different assumptions, definitions, and methods, operating at different levels of analysis, and making connections with various other disciplines. When faced with an array of perspectives, the need to characterize commonalities among theories, while still recognizing differences, becomes apparent. Here, to set the

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stage for main categories of creativity theories, four thematic frameworks are discussed: a more scientific versus a more metaphoric quality, a purely theoretical versus applied focus, level of creative magnitude, and emphases among the so-called six P's and five A's of creativity. While there is some overlap among these themes, they may be regarded as largely independent, so that any particular theory might partake any combination of the levels of these frameworks.

Scientific Versus Metaphoric Theories

One common distinction, in many areas of study, is between more overtly scientific theories versus more metaphorical ones. Scientifically-oriented theories have an underlying goal of mapping the empirical reality of creative phenomena and aspire to traditional scientific standards: a search for objective truth, generating empirically falsifiable hypotheses, and developing formal or computational models. In contrast, metaphorically-oriented theories offer a more speculative stance focusing on provoking new understandings and possibilities and offering a moderating counterbalance to the stark empirical focus of scientific theories. Such theories are of maximal use when they balance speculation with agreed-upon methods and standards of empirical exploration and peer review. The varied, complex, and interdisciplinary nature of creativity naturally lends itself to exploration by both kinds of theories.

Theoretical Versus Applied

Creativity researchers have varied goals. For some, it is understanding creativity as its own phenomenon, in a disinterested, 'pure' scientific way, without overt interest in the practical applications or implications of discoveries. Others' goals are more pragmatic – usually, to increase creativity by identifying factors associated with its natural development (and to create environments with such characteristics) or by designing specific interventions to promote creative thought. While some theories focus more on one than the other, most have implications for both pure and applied research.

Levels of Creative Magnitude

Another framework concerns what may be called level of creative magnitude. Not all instances of creativity are equal. A standard distinction is between 'Big-C' (truly great, history-making instances of creative breakthroughs among eminent individuals) versus 'little-c' creativity (a private but novel insight or realization in an ordinary person). Kaufman and Beghetto (2009) proposed two additional categories of creative magnitude: a 'mini-c' category provides more room for subjective or personal instances of creativity; a 'Pro-C' category allows for professional-level creators who have not yet attained eminence, but who are well beyond little-c creators in knowledge, motivation, and performance.

A focus on a particular magnitude will constrain a researcher's basic questions, sources of data, and methodologies. Widely acknowledged Big-C or Pro-C achievements are more often approached by the analysis of archival data (creative products, laboratory notebooks, sketches, etc.) or by carefully targeted laboratory or case study investigations on select individuals. In contrast, little-c and mini-c creativity lend themselves to more varied methods, including laboratory experiments, paper and pencil surveys and inventories, microgenetic studies of creative behaviors, and introspective self-reports of the subjective aspects of the creative experience.

The Six P's and Five A's of Creativity

Another common framework, described by Kozbelt et al. (2010), involves the so-called six P's of creativity: *process*, *product*, *person*, *place*, *persuasion*, and *potential*. Since this alliterative scaffold nicely organizes many issues in the study of creativity, it is a useful way to compare the scope of different theories.

Theories that focus on the creative process aim to understand the nature of the mental mechanisms that occur when a person is engaged in creative thinking. Process theories typically identify different specify stages of processing or particular mechanisms as the components of creative thought. Another approach focuses on creative products: works of art, inventions, publications, etc. Products can usually be counted, permitting quantitative objectivity, and they are often available for judging, so inter-rater reliability can be readily determined – two substantial advantages; however, products themselves say little about their creators or the creative process that engendered them.

Studies of the creative person (or personality) tend to focus on identifying and understanding individual difference traits that are associated with creativity, such as intrinsic motivation, wide interests, openness to experience, and autonomy; some traits also seem more pervasive either among persons in artistic or scientific domains. The actualization of creativity also depends on the place or setting in which an individual resides. Research on place factors is especially useful in defining such interactions between persons and environments, which tend to be optimal for creativity when there are opportunities for exploration and independent work and when originality is valued.

Another view describes creativity as persuasion: creative people change the way others think, so they must be persuasive to be recognized as creative. This notion shares assumptions with a number of theories, in which persuasive individuals are the ones who influence the direction taken by a domain. Finally, the notion of creative potential addresses the need to examine and understand the latent capacity for creative thought in children and others, who may have what it takes ultimately to be creative, but who require

educational opportunities or other support before they can do so. Obviously, the goal of realizing creative potential is a major goal in education, so studies of creative potential often have a strong practical focus.

Beyond the classic framework of the P's of creativity, a more recent and roughly analogous model, Glăveanu's (2012) so-called five A's of creativity, has also been proposed. The five A's (and their P analogues) are: actor (person), action (process), artefact (product), audience (press), and affordances (also press). While there is some degree of overlap, the five A's framework places greater stress on socio-cultural modes of creativity and distributed cognition, compared to the emphasis on the individual within the P's framework.

Categories of Theories of Creativity

Overview

Ten major categories of theories are now described: *Developmental*, *Psychometric*, *Economic*, *Stage and Componential Process*, *Cognitive*, *Problem Solving and Expertise-Based*, *Problem Finding*, *Evolutionary*, *Typological*, and *Systems*. The goal is to provide a big-picture overview of each type – for more detail, see Kozbelt et al. (2010). Most theories described here have been discussed in the literature for at least several decades, boast considerable research support, and span multiple P's (and A's), levels of analysis, and methodologies. Excluded are theories that are limited to understanding a specialized subtopic – like creativity's relation to mental illness or to personality, its biological underpinnings, cultural differences, and so on.

Developmental Theories

Developmental theories pragmatically aim to understand the roots of creativity, as suggested by the backgrounds of Big-C creators, but they also often suggest how to design environments to fulfil creative potential (Feldman, 1999). They mainly emphasize the person, place, and potential aspects of creativity (and analogous A's), and range from mini-c to Pro-c. Early developmental theories were devised by examining the lives and backgrounds of eminent creative persons; these suggested that particular developmental experiences were correlated with later creativity, such as exposure to diverse experiences, and not being overly restricted.

Other theories focus on family structure (e.g., birth order, ordinal position within the family, age interval between siblings, etc.). For instance, evidence suggests that middle children often rebel against their parents and the status quo, to attract attention away from older siblings whose maturity earns them praise. Rebellion may occur within the context of the family, in one's thinking, or, during adulthood, in artistic or scientific revolutions (Sulloway, 1996).

Longitudinal methods provide another powerful perspective on development. Findings from this tradition indicate that during their childhoods, the truly gifted also had the support to make cognitive and emotional transitions – one from general to creative talent, and the other from capability to a motivational state which leads directly to actual achievement. Such studies reinforce developmental theories of creativity that consider cognitive processes, motivation, affect, and personality.

Psychometric Theories

Psychometric theories focus on measurement and thus inform all other creativity theories (Guilford, 1968). Emphasizing products (or artifacts) over the other P's (or A's), they range from little-c to Big-C creativity and are concerned, among other things, with the reliability (agreement or consistency of measurement) and validity (accuracy) of assessment, which are issues in all creativity research. Besides establishing basic principles of the measurement of aspects of creativity, psychometric theories have also addressed issues like how creativity differs from intelligence, the relation between performance on convergent thinking (one right answer) tasks and divergent thinking (many correct answers) tasks, and the extent to which creativity is rooted in particular domains of activity (like music, mathematics, or writing) versus being a domain-general ability.

Economic Theories

Another category of theories draws on economic metaphors (Rubenson and Runco, 1992). The macro-level quality of these theories encompasses all of the P's (and A's) except process (or action), and spans little-c to Big-C creativity. There are several economic or investment theories of creativity. Some describe the market for creativity, which illustrates macro-level processes and interactions involving the allocation of resources. Markets can provide benefits to certain behaviors or impose costs upon them, which can be defined in psychological terms. Other research has examined the market for creative behaviors, defining a creative class or segment of society and arguing that a key component of the market for creative work is tolerance; unconventional people sometimes need to be tolerated, and creative societies do a good job of that. Other work has emphasized investments in creative behavior, in that creativity can result when a person buys low (i.e., invests in an idea which is currently unpopular) and then sells high (i.e., the idea gains respect).

Stage and Componential Process Theories

As noted earlier, many models of the creative process have been proposed. Some attempt to understand the creative process in terms of stages, which can be sequential or recursive; others focus on underlying componential cognitive processes. Such models range from mini-c to Big-C creativity and obviously emphasize process (or action) over the other P's (or A's).

Stage theories usually try to understand how moments of creative insight occur, typically by positing a particular sequence of processes – for instance, [Wallas's \(1926\)](#) venerable model of preparation (gathering information and defining a problem), followed by incubation (taking some time away from the problem), followed by illumination or insight (having a sudden realization of the answer), followed by verification (applying the solution). Since the strict linearity of such models has been largely discredited, more recent models have acknowledged the need for recursion, whereby an individual may cycle through the stages multiple times, in various combinations.

As an alternative to sequential or recursive stages, some recent theories have defined the creative process in terms of component mechanisms or processes, which operate in a more inter-connected manner. Various componential frameworks emphasize factors like domain-relevant skills, cognitive style, knowledge of heuristics for generating novel ideas, attitudes towards specific tasks, and perceptions of one's motives, and how these components interact to generate novelty.

Cognitive Theories

Cognitive theories emphasize the creative process (action) and person (actor): process, in emphasizing the role of cognitive mechanisms as a basis for creative thought; and person, in considering individual differences in such mechanisms. Some cognitive theories focus on universal capacities, like attention or memory; others emphasize individual differences, like those indexed by divergent thinking tasks; some focus on conscious operations; others, on preconscious, implicit, or unintentional processes.

One classic cognitive theory, by [Mednick \(1962\)](#), holds that creative insights result from associative processes in memory. In this view, ideas are chained together, one after another, and more remote associates tend to be more original. This perspective argues that more creative individuals have flatter hierarchies of associations than less creative individuals; thus, more creative people have many more relatively strong associates for a given concept, rather than only a few. This is thought to provide greater scope for the simultaneous activation of far-flung representations, which some believe is an important engine of creative thought.

Along similar lines, another cognitive theory focuses on how concepts are combined to generate novelty. Research suggests that conceptual combination – bringing two different sets of information together – is often involved in creative ideation, that original insights are more likely when two disparate features are brought together, and that connections between these concepts might only be seen at a very high level of abstraction. This kind of thinking has been called metaphoric logical, the idea being that something like “angry weather” is only comprehensible in a non-literal fashion. Such processes may suggest creative alternatives to well-worn lines of thought.

More generally, research in the ‘creative cognition approach’ tradition, another important contemporary view of creativity developed mainly by [Finke et al. \(1992\)](#), has likewise emphasized ideas drawn from cognitive psychology. These include conceptual combination, conceptual expansion, creative imagery, and metaphor, all of which are used to understand how individuals generate ideas and explore their implications in laboratory-based invention and design tasks. Such processes are thought to play out in two fundamental regimes of thought: generating ideas and exploring their implications. In practice, the two are strongly interleaved and combined in the ‘geneplore’ model of creative thought (from *generate* + *explore*).

Finally, metacognitive processes (thinking about one's own thinking) are also frequently tied to creativity. Many tactics for increasing creative problem solving have been proposed and popularized, including “think backwards,” “shift your perspective,” “put the problem aside,” and “question assumptions.” Tactical thinking is especially useful for programs designed to facilitate creative problem solving since they are a function of conscious decisions and can be employed whenever necessary.

Problem Solving and Expertise-Based Theories

A related major category of creativity theories, again drawn from cognitive psychology, emphasizes problem solving processes and expert knowledge ([Weisberg, 2006](#)). This is largely a theory of the creative person (actor) and process (action): person, in emphasizing domain-specific expertise as necessary for significant creative achievements; process, in emphasizing how traditional cognitive psychological concepts like problem representations and search through problem spaces explain how people devise creative solutions to problems. Such principles can be readily applied to ill-defined problems, which are under-specified and which admit multiple good enough solutions, rather than one uniquely correct answer. Ill-defined problems can often be broken into several well-defined problems, which can then be solved in familiar ways. Moreover, one can search not only for a solution, but also for an appropriate way to formulate a problem.

The problem solving/expertise view boasts support from many lines of evidence. Many of the processes and structures described in the creative cognition approach can be straightforwardly related to those of the problem solving/expertise view. Archival studies of great creators reinforce the importance of domain-specific knowledge for high-level creative achievement, for instance in the ‘ten-year rule,’ whereby at least a decade of intensive work in a domain is required before a creator produces any original works of lasting value. The archival study of creative episodes taken from the notebooks of eminent scientists has also generated a number of computational models of the creative process, which have replicated many major scientific discoveries.

Overall, the problem solving/expertise view regards creativity as a largely rational phenomenon, in being amenable to rigorous empirical study by researchers, and to meaningful strategic guidance and long-term learning by creators themselves. Thus, another advantage of this view is pragmatic: its foci are strategic factors that individuals can partly control; at the same time, the problem solving/expertise view acknowledges that Big-C problems are extremely difficult.

However, this view has some limitations. For instance, expertise is a necessary but not sufficient condition for Big-C creativity; many other factors also contribute to high-level creativity. Also, the expertise view arguably overstates the role of cumulative deliberate practice, at the expense of talent. Finally, some have criticized the computational approach to creativity as fundamentally misguided.

Problem Finding Theories

Problem finding, another influential view of creativity, originally postulated by [Getzels and Csikszentmihalyi \(1976\)](#), can be seen as a reaction against the traditional problem solving approach to creativity. The problem finding view holds that the problem solving view is inadequate to explain how creators come to realize that a problem exists in the first place and how they are motivated to bring their subjective experience to understand the problem. Problem finding is often regarded as independent of problem solving, and it is mainly as a theory of the creative process (action); it can also be seen as a theory of the creative person (actor). In terms of creative magnitude, problem finding is often construed as an instance of mini-c creativity, though there is also room for higher levels.

Early research on problem finding focused on understanding the exploratory behavior of creative visual artists, with a strong emphasis on their motivational factors and existential concerns. Since problem finding is more subjectively-oriented and harder to define than problem solving, it is more difficult to cite evidence definitively bearing on problem finding, either pro or con. The problem finding view may also overemphasize on-line discovery, at the expense of considering habitual behavior patterns.

Overall, the distinction between the problem solving and problem finding frameworks may be less due to substantive differences between the theories and more a matter of the taste of individual scholars. In any case, more recent models have often focused less on such labels and more on the nature of the underlying processes, using terms like 'problem construction' to encapsulate the constellation of processes involved in devising a creative solution to an ill-defined problem.

Evolutionary Theories

Researchers have proposed several theories of creativity drawing on ideas from evolutionary biology. Of these, a strong candidate for the most comprehensive general theory of creativity is the Darwinian model of [Simonton \(1999\)](#), which, to varying extents, covers all of the P's (or A's) of creativity: person and potential, in identifying dispositional and developmental idiosyncrasies associated with the realization of initial creative potential into actual creative achievements; process, in laying out a two-step model of ideation and elaboration, in which chance combinations of ideas play a paramount role and whose complexities are hard to control; product, in noting sometimes unreliable initial assessments versus longer-term stable judgments of creative artifacts; place, in identifying social factors leading to outstanding creativity; and persuasion, in emphasizing how social dynamics establish verdicts of creative outcomes. More than any other theory, Simonton's Darwinian view aims to understand the nature of genius, eminence, and Big-C achievements.

The basis of the Darwinian model is a mental process involving the blind generation and selective retention and elaboration of ideas. Ideas are combined in some blind fashion, typically below the threshold of awareness; the most interesting combinations are then consciously elaborated into finished creative products; these in turn are judged by other people. This process can be elaborated into a mathematical model that accurately describes how creative productivity unfolds over the lifespan, and a great deal of quantitative archival evidence supports the predictions of the theory. Indeed, the model's quantitative basis gives it a rigor unsurpassed by any other major theory of creativity.

The Darwinian view has major psychological implications. Given the complexity of the creative process, creators should have little control over guiding the progress of their works. Creators should also not be particularly good judges of their ideas or works. Moreover, once works are finished, creators have little control over their fates, since this is a social judgment; thus, mass-production is the optimal strategy for those seeking eminence.

Despite its comprehensiveness, the Darwinian view can be critiqued along several lines. It arguably over-emphasizes the role of chance factors in explaining creativity. Also, despite its mathematical parsimony, process particulars are left unspecified. Moreover, an array of theoretical arguments has also been offered that dispute fundamental premises of the Darwinian view, as well as objections based on empirical data that do not conform to the predictions of the theory. Finally, however well the Darwinian view works as a first approximation to many phenomena in the study of creativity, it explains little of the considerable error variance in relations between productivity and eminence, age and productivity, the production of masterworks versus minor works, or in creators' varied career trajectories. Understanding such individual differences is a focus of the next category of theories.

Typological Theories

One approach to understanding variation in creators' personalities, working methods, and career trajectories has been to posit typologies of creators, who differ in systematic ways ([Galenson, 2006](#)). A number of such frameworks exist, many of which

have elements in common; however, at least as often, they differ in their particulars, so that different typologies can be difficult to relate to one another. As a group, however, typological theories differ from the nomothetic (or universalist) emphasis of other theories, in aiming to explain variability among creators rather than overall trends. Various typologies touch on aspects of all of the P's (or A's) and levels of creative magnitude.

Typologies are most often cast as a set of categories, often construed as mutually exclusive. This is convenient for readily understanding the big picture, but it may be misleading when a typology is generalized too broadly, or individuals are made to try to fit into a category they may only partially exemplify; this latter point also raises the issue of potentially poor reliability in categorizing individual creators. Setting up mutually exclusive categories is also limited in precluding multi-dimensionality, which can seem antithetical to the multi-faceted nature of creativity.

An alternative is to cast individual differences not in terms of discrete categories, but multiple continuous dimensions, which creates a space of possibilities in which a particular creator can be located. Going even further, at their best, typological theories not only note the factors along which creators differ but attempt to relate these factors to each other across multiple levels of analysis.

Considered as such, typological theories are promising for achieving an integrated, multi-level understanding of creativity, as research moves forward. A key virtue of such an approach is the potential rapprochement between historically opposed camps in the study of creativity, such as the problem solving/expertise and Darwinian approaches, both of which can be at least partly absorbed into typological models. It is debatable whether such a unified theory of creativity is possible – or even desirable, from the standpoint of pluralism raised at the outset of this article. However, taking into account the unique and highly varied characteristics of individual creators is an issue that any comprehensive account of creativity ultimately has to face. These higher-level themes are also characteristic of our final category of models: 'systems' views of creativity.

Systems Theories

Some of the broadest and most ambitious theories of creativity take the view that creativity is best conceptualized not as a single entity, but as a phenomenon emerging from a complex system with interacting subcomponents. Such 'systems' theories take a broad and often quite qualitative contextual view of creativity. A number of such theories have been proposed, almost all of which address each of the P's (and A's), though with different emphases, depending on the relevant level of creative magnitude.

One influential systems theory, devised by Csikszentmihalyi (1988), takes as its starting point not the question, "What is creativity?" but rather, "Where is creativity?" In this view, creativity emerges via three interacting components: 1) the domain, or body of knowledge that exists in a particular discipline at a particular time; 2) the individual, who acquires domain knowledge and produces variations on the existing knowledge; and 3) the field, comprised of other experts and members of the discipline, who decide which new works are worth preserving for the next generation. Each has a role in determining what counts as creative.

This perspective involves multiple factors and takes a very broad view of creativity, emphasizing the ubiquitous role of place (or environment) among the P's, especially for Big-C achievements. It also elaborates the nature of the creative person by detailing how individuals other than the creator contribute to the emergence of creativity and de-emphasizes internal processes and individual contributions, placing more emphasis on collaborative creativity and the societal conditions which can best foster genius. It likewise highlights issues like the importance of 'gatekeepers' like journal editors and gallery owners, who play a major practical role in determining which contributions will be given the opportunity to be judged as creative.

This framework has many advantages, not the least of which is acknowledging the importance of extra-personal, socio-cultural factors, which were previously underemphasized in creativity research. However, the qualitative nature of the model makes it difficult to test hypotheses unambiguously, and its strong inter-disciplinarity could be a pragmatic roadblock – though for a rich understanding of creativity, many more variables and levels of analysis need to be considered besides a quantitative, empirical approach to individual traits.

Another view, pioneered by Gruber (see Wallace and Gruber, 1989), is the 'evolving systems' approach. This has mainly been applied to understanding the unique attributes of the creative person, via detailed archival case studies, which are motivated by a particular question – for instance, how Darwin devised the idea of evolution by natural selection. Such case studies focus less on understanding the particulars of one creative act than on how those particulars fit into an individual creator's goals, knowledge, and reasoning, plus larger social forces and creative paradigms.

The emphasis of the evolving systems approach is on dynamic, developmental processes that play out in complex ways and contexts, over varied timescales. Several key concepts provide a framework for understanding creative individuals in the midst of such complexity. One is the notion that great creators use an 'ensemble of metaphors' in their thinking, which together characterize a developmental process leading to creative meaning-making. Another is that of a 'network of enterprises,' a system of goals that describes how an eminent creator may work on seemingly disparate topics and projects, consecutively or concurrently, and continually evolve a sense of the relations between the topics. Such analyses put considerable interpretive pressure on researchers, particularly in absorbing the details and global qualities of a large amount of material and in avoiding pat, hindsight-biased conclusions about a creator's entire career. However, if used judiciously, this method has the potential to characterize creators with a qualitative richness and rigor unmatched by any other approach.

Future Directions for Creativity Theories

Pluralism, Again

At the outset of this article, pluralism was put forth as a way of celebrating the diversity of creativity theories currently in the literature. The principle of pluralism may also prove useful in guiding future directions as scholars develop, refine, and connect theoretical perspectives. Such connections between different theoretical perspectives could potentially lead to attempts at grand, unified theories of creativity; however, unified theories or not, making connections would strongly benefit creativity research anyway, as researchers better situate their theories in the broader theoretical and empirical character of the domain, acknowledging and incorporating the plurality of perspectives that have taken root and flourished. This applies to all the principal frameworks outlined earlier – including the six P's and five A's of creativity, the various levels of creative magnitude, a pure research versus applied focus, and a more scientifically-oriented versus metaphorically-oriented approach.

What Do We Know? A Critical Reconsideration of Theories of Creativity

In the light of the preceding exposition and discussion of current theories, let us revisit a theme somewhat related to the scientific-metaphoric distinction: the question of what researchers have actually learned about the nature of creativity, and what role theories have played in that process of discovery.

Creativity researchers work in an inherently uncomfortable position. At any level of magnitude, creativity by definition involves variety and unpredictability, which raises a host of conceptual, methodological, and measurement complications. Beyond that, a more subtle, but also more insidious, issue is that creativity as a topic of study is not some independent natural science phenomenon, whose physical workings can gradually be understood in reasonably objective terms. Rather, creativity is an all-too-human enterprise, one which our most illustrious forbears – Newton, Michelangelo, Mozart – probably had a far richer experience of – and, perhaps, deeper knowledge of – than virtually any contemporary creativity researcher.

This observation presents enormous conceptual and practical difficulties. This is especially true for researchers of Big-C Creativity, who must grapple with phenomena of unmatched depth, richness, and complexity, and who must achieve some multidisciplinary understanding of the particulars of the domain of expertise of their subject. (The issue is somewhat less threatening in the realm of little-c creativity, since the creativity of researchers can – hopefully – reasonably be expected to exceed that of most of their subjects.) It is an open question, to what extent any contemporary theory is a substantive improvement on the best armchair speculation antedating the modern psychological approach to the study of creativity. Indeed, from a hard-nosed, ultra-scientific perspective, many so-called 'theories' of creativity are arguably not well articulated or substantive enough to be informative about the phenomenon one way or the other.

The written record of eminent creators' armchair theorizing about creativity thus stands as an elephant in the creativity theory room. If the study of creativity is to be scientifically respectable, it surely needs to go beyond what could merely be arrived at by intuition, like any mature empirical discipline. This includes making falsifiable and counterintuitive predictions (not just common-sense post-dictions), as well as making contact with well-developed neighboring domains and spanning multiple levels of analysis. Doing so need not imply a single unified theory of creativity or an abandonment of metaphorically-oriented theories, but it does require high critical standards. A well-developed theory of creativity also does not entail making error-free predictions. In many ways, the domain of creativity research is more similar to contingency-intensive disciplines like history or biology, both of which have seen the development of rigorous, beautiful theories with great explanatory power, even if they cannot predict the future in great detail.

In considering the prospects and nature of reasonably rigorous theories of creativity, several criteria for the value of a theory are worth remembering. One is accuracy, or correctness: does a theory make good predictions and yield reliable knowledge about a phenomenon? Another, however, is fruitfulness: the capacity of a theory to disclose new phenomena or relations among phenomena and to generate testable hypotheses. Some very accurate theories are sterile; some wrong theories are nevertheless very generative. In the history of science, many wrong ideas have been enormously useful, if only because the process of disproof can lead to greater knowledge and integration. For a topic like creativity, where precise predictions may not be a reasonable goal, fruitfulness may be the better criterion of a theory's usefulness.

How have current theories of creativity fared by these two criteria? Given the complexity of the phenomena of creativity, it is encouraging that many contemporary theories are able to do a reasonable job accounting for existing data. However, ironically, despite the variety and number of theories in the literature, it is not clear that they do well by the criterion of fruitfulness. Arguably, a book like [Eckermann's \(1836/1998\) *Conversations of Goethe*](#) contains more wisdom and could spawn more hypotheses about the nature of creativity than virtually any contemporary psychological overview.

Along these lines, it is also arguable that what is really needed to advance the study of creativity is not a proliferation of more theories, but instead, more, better, and richer data, which could be used to put useful, direction-providing constraints on existing theories. Allied to such datasets, the application of more sophisticated statistical methods – including latent variable models and hierarchical or multi-level regression analyses – would go a long way to documenting and enabling an understanding of the richness of creative phenomena. Importantly, these would also serve to encourage the development of theories that were conceptually equipped to take advantage of added empirical rigor.

In terms of sub-topics within the study of creativity, the potential for the development of theories that go beyond the armchair seems most promising for non-first-person, multivariate aspects of creativity – precisely its aspects that are not amenable to

introspection. These include the details of and variability in the creative process, the neural and other biological bases of creativity, and larger-scale socio-cultural and trans-historical patterns. Empirical study can greatly benefit, or at least most uniquely contribute to our understanding of these aspects of creativity, which would indeed constitute a real advance on the long tradition of armchair speculation.

Conclusion

The variety of current creativity theories has plusses and minuses. On the plus side, there is a pluralistic array of perspectives available. These admirably attempt to understand many aspects of this complex phenomenon, account for current data reasonably well, and have potential for a great deal of integration and cross-connection. On the minus side, many theories have not progressed far beyond earlier speculative claims and have often failed to spark the identification of new phenomena and counterintuitive testable hypotheses. While it is too early to forecast the fate of theories of creativity, and the enterprise of studying creativity more generally, it seems likely that the two will rise or fall together. For any real conceptual progress to occur, existing theories must be continually constrained by more and better data and analyses and generate new constructs for measurement and analysis in their turn.

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Time and Creative Problem Solving

Creativity is often defined as a syndrome or complex, with the premise that it is multifaceted. Not surprisingly, several aspects of creative behavior relate to time. This chapter reviews this relationship. It covers several aspects of creativity.

Time has been tied to the cognitive bases of creative thinking. Creative thinking has been defined in associative terms, with the prediction that individuals tend to generate problem solutions in concatenated chains of associations. The first few associations are usually rote, obvious and unoriginal, but the later and more remote associations become increasingly original. Time is relevant to the associative basis of creative thinking because it takes time for an individual to move through obvious ideas to find the remote associates. Predictions about remote ideas being original have been repeatedly confirmed.

One of the most commonly cited models of the creative process was proposed in 1926 by Graham Wallas, who indicated that problem solving consists of the four stages of preparation, incubation, illumination and verification. Incubation implies that some time must elapse before coming up with a creative solution. In the preparation stage, people work on the problem consciously and actively seek for a solution. However, if they cannot arrive at a creative solution and traditional methods do not work, they stop to search for an alternative. It seems that they give up. The incubation stage starts just after preparation. During that time, the individual is not consciously working on the problem - but is working on a preconscious level. The preconscious often succeeds in solving the problem because it encounters fewer constraints than conscious (and logical) efforts. In 1971, J. P. Guilford claimed that Wallas' description of the stages was primarily designed for problems of great importance - problems that demand a long work period. Guilford proposed that Wallas' steps are involved in solving ordinary everyday problems, and they are compressed. Thus, even in your daily problems, you apply these four stages to come up with a creative idea. It is not always obvious to the individual because the stages are compressed.

The need for incubation (and time) was also noted by Sidney Parnes. He distinguished between "make it happen" and "let it happen" strategies for creative problem solving. The former is exemplified by very intentional and systematic tactics, such as working backward (starting with the solution and working back to the initial state) or turning a problem on its head. The latter is exemplified by taking a walk or turning to another task; the assumption is that incubation will occur. This, in turn, assumes that time (for incubation or at least thinking and processing) is useful.

Incubation is often preceded by a state of fixation. This may lead to an impasse as an affective result of a lack of progress. The affect is characterized by negative emotions emerging and feeling stuck. The individual may consciously quit considering the problem. This is the time required for incubation: in other words, the time that is not predated by fixation cannot be regarded as incubation.

Howard Gruber (1993) described how many seemingly instantaneous and sudden insights are protracted and spread out over time. He suggested that insight, or the "Aha! Movement", is *not* a sudden process. Each insight supposedly has a developmental history. According to Gruber, the mastery of creativity requires repeated practice, implying that a great deal of time must be available and invested. For this reason, hard work and repetition are important for creativity. He called this process *constructive repetition* and defined it as a conscious repetition and revision of a concept to establish its best form for a creative product. As an illustration, Beethoven revised his works 20 or 30 times before he decided the final, acceptable form of the piece. This is contrary to the popular conception of insights as sudden. Illumination may seem sudden, but what leads up to it may require time to be invested.

Beeftink et al. (2008) examined the differences between interruptions and breaks (often a matter of choice) on impasses and insights. In the interruption condition, participants are forced to switch tasks at a predetermined moment; in breaks, they can switch

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This article is an update of M.A. Runco, N. Cayirdag, Time, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 485–488.

tasks when they chose to do so. Both breaks and interruptions contribute to impasses, but interruptions do not contribute to solving more insight problems unlike breaks. Unlike incubation, where the preconscious continues to work on the problem, a break is actual and denotes conscious time away from the task. Taking time away may be required by one of the most general tactics of creative problem solving: changing one's perspective. Changes of perspective can break a mental set or routine, thereby allowing creative insight. Perspectives are often changed literally by finding another viewpoint or way to represent the problem. A new perspective can also be found simply by taking time away from the problem. Every writer knows that one's own work can be difficult to edit if the person is immersed in it. But if you take time away, editorial work is easier. We become more objective and sensitive to details. The same is true in other areas, where time provides perspective.

Studies examining the relationship between time and creativity mostly focus on fluency and originality. Another component of divergent thinking is flexibility. According to Mark Runco, flexibility is more related to coping than other indices of divergent thinking. Flexibility provides the options which are necessary for adaptation. One of the measures of flexibility is category shifts, wherein ideation moves from one category to another. Category shifting and time spending are positively correlated. When people stay in a certain category and generate ideas in it, the process is quicker and generates more ideas during a given time. However, category switching takes longer. The latency between categories is higher than the latency within a category. [Acar and Runco \(2017\)](#) examined the latency between consecutive ideas generated in think-aloud sessions. They found that the average latency was 6.44 s, whereas it was 5 s. higher when people switch from one category to another. They also found that different types of divergent thinking activities require different latency. Generating ideas for figural items takes 2.5 s longer than generating ideas for verbal items.

Timed Tests

Creative potential is often estimated by special tasks or tests. When these tasks or tests are administered, special instructions must be given. Otherwise respondents tend to view the tasks as similar to the academic tests most of us have experienced; and when they do this, creativity becomes a low priority. On academic tests, it is important to find the correct answer, spell it correctly and earn a high grade. When generating original responses to an open-ended task, there may be no correct answer. There may be many appropriate answers, some of which are original and some of which are not, but there is no one correct answer.

To promote the originality of the respondents, grades, conventional answers and time must be deemphasized in the task instructions. Instead of imposing a time limit, examiners should allow the individual to make the pertinent decisions about investing time and effort for him- or herself. By allowing individuals to decide for themselves how much or little time to allocate to the task, the distinctiveness of divergent thinking (and originality) from convergent thinking is maximized. Performance on a test is determined by the respondent's intrinsic motivation, which often facilitates creative thinking. Flexible time limits also allow the individual to find remote associates and perhaps incubate.

There is a common criticism of tests, including tests of creativity, when they are timed. In the natural environment, creative work rarely has a timed component, at least one similar to that used with tests. If we wish to predict real-world creative work, the predictor should require the same tendencies as the criterion behavior. This implies that if creative work in the natural environment is rarely timed, so too should the assessment of creative potential be untimed. According to [Runco \(2016\)](#), even the word "test" is misused in creativity. There is no test that measures creativity. Tests are merely estimates of the potential for real-world creative activity and only show what a particular individual might do. However, because they are called "tests," they are given like other tests with time limits. Thus, there must be constraints in research and educational settings.

Test-like environments may also cause bias against older persons' creativity. According to the peak and decline model, creativity is a characteristic of younger people and peaks in the thirties. Then it declines further as one ages. [Runco and Charles \(1997\)](#) criticized this model because of the implied ignorance of old people's slowness and lack of familiarity with testing. They have lower scores not because they are less creative, but they are slower due to a lack of familiarity with tests compared to younger people. Young people feel more comfortable with tests because they have had a lot of experience during their education. A lack of expertise in testing may cause a cohort effect against the elderly. [Keyes et al. \(2010\)](#) define cohort effect as the specific historical influences on a specific age group. For instance, children born during World War II may have unique similarities not common in any other birth group. The cohort effect is different from the age effect. The age effect is the physiological difference caused by aging, while the cohort effect is social and personal differences caused by common life experiences. A possible cohort effect for the 21st century's young population is test-wiseness.

Developmental Trends and Rates

Time is often used as a categorical independent variable. This is exemplified in longitudinal studies, where various follow-up assessments are conducted after an interval has elapsed. Louis Termán conducted the most famous longitudinal study, although his (gifted) subjects were selected based on IQ and traditional intelligence. Time is also implied by other developmental research, where changes depend on maturation and the passage of time. Some longitudinal studies have found discontinuities and changes that would not be apparent with any other research design. Other studies have found continuities. Consider Robert Albert's longitudinal study of exceptionally gifted boys. His investigation covered more than decades. One of the key findings of a recent follow-up assessment is that certain subjects are "cross overs." By this, Albert meant that subjects change their interest from one domain to another.

The change became apparent only because the longitudinal research design allowed a comparison of career interests and general preferences at several points in time. There are also continuities that can be uncovered only through longitudinal research designs. Mihályi Csikszentmihalyi and Jacob Getzels, for instance, found that art students who invested more time in the preparation of their subject matter were more original - even 18 years later.

The domain specificity of the creativity peak has also been highlighted by Harvey C. Lehman, and later by Dean K. Simonton, in research on exceptional achievement. This line of work suggests that philosophers and social scientists need a longer time to master products than poets and mathematicians. Usually poets and mathematicians peak in their twenties, but social scientists peak later, in their thirties or forties. Development is a lifelong process, and certain discontinuities appear late in life. Some may facilitate creative work. Many older artists are, for example, less concerned with criticism than they were when younger, and this allows them to focus on authentic self-expression and experiment in their work. Martin Lindauer and others have found that many of the most creative artists intentionally changed their style as they got older - often in the seventh or eighth decade. These changes to an "old age style" may have contributed to the artists maintaining a fresh perspective and creative hand. Such changes and perspectives assume that time must pass - the old age style is simply not found in younger individuals. Elapsed time is sometimes not the concern. Time can also be used to calculate other indices of development, such as "rate." Rate is the standardization of occurrence as a function of time. Of relevance here are rates of development and creative productivity that reflect individual differences. There is, for instance, evidence that various facets of thought develop at different rates. J. P. Guilford described in detail different kinds of ideational flexibility and how they mature and fail at different rates. Using Guilford's own terms, the "flexibility of classes" is lost at a different rate than is the "flexibility of transformations."

Kim (2011) examined the development of creativity from a broader perspective. Instead of individual's life-span development, she analyzed the changes in creativity by decades. She analyzed the TTCT scores for the years 1966, 1974, 1984, 1990, 1998 and 2008. Her findings showed that creativity has declined across recent years as measured by TTCT. This implies a reverse "Flynn effect", which refers to increments in IQ in younger generations.

Expertise as Time Invested

Raymond Cattell and John Horn suggested two kind of intelligence: fluid and crystallized. Fluid intelligence is the ability to solve novel problems with a little to no previous knowledge. For instance, someone suddenly realizes that a hanger can be used as a back scratcher. Crystallized intelligence, by contrast, is remembering and using information acquired by previous experience and education. For instance, solving a new math problem requires previous knowledge and expertise in math. In Ceci and Liker's (1986) classic study, researchers asked the same problem to two groups of men: experts and non-experts in the field. There was no significant IQ difference between the groups. Results showed that the experts used more sophisticated and complex strategies to solve the problem than the non-experts. Experts solutions are richer and more organized, and this group is more aware of what they do not know.

Some domains require years to develop expertise. Various investigators have suggested that 10 years (or 10,000 hours) need to be invested in a domain for expertise to develop. To the degree that expertise is necessary for creative work, this may, indeed, be a requisite investment. In some areas, expertise may be easier to obtain and requires less of a temporal investment (domains that depend the least on familiarity with a body of information). What may be surprising is that expertise may inhibit creative insight. Experts sometimes make assumptions that preclude original thinking. They have invested so much into their areas of expertise that they are resistant to alternatives.

Dean Simonton described other requisites for high-level achievement. He pointed to three tendencies of eminent persons: they start their careers early, they are productive and they live a long time. Time is involved in each of these. Time is also implied by economic and investment theories of creativity that use the parallel idea that creative persons tend to invest a great deal in their work. Investments may be temporal. This may sound like another way of saying that expertise takes time to develop, but here it is more that the person concentrates frequently on the task at hand or field of choice. It is possible that investment can work against creative success. In this sense, the psycho-economic theories of creativity support the idea that expertise can sometimes inhibit original thinking. Theoretically, an individual who has invested a great deal in one idea or mode of thinking would experience a "depreciation" of his or her knowledge if the new thought supplants the old; in fact, this may lead to resistance of the new lines of thought.

Subjectivity of Time

The research above that notes the inhibitive effects of time constraints should not be taken to suggest that everyone would be disturbed by deadlines. According to cognitive evaluation theory, the influence of limits is only likely when perceived as pressure by the person. This is the subjectivity of time. Along the same lines, time may be conceived as occurring in routines and schedules, thereby easily perceived as boring or repetitive. As such, they may make it difficult to maintain one's creative efforts.

Creative individuals may have certain cognitive capacities and abilities to produce creative ideas, but they must also be interested in using those capacities and abilities while working. This is described as "intrinsic motivation." If intrinsically motivated, the individual will invest time and effort into a task, problem or domain. Importantly, an event may increase or decrease intrinsic

motivation depending on its meaning for the recipient. Recall that, according to cognitive evaluation theory, if an event is perceived as a pressure to reach a goal (as controlling), intrinsic motivation is undermined. On the other hand, if an event is perceived as an internal locus of causality for behavior (informational rather than controlling), it enhances intrinsic motivation. Therefore, perception of time limits counts.

Koestner et al. (1984) examined the influences of limits on children's creativity and intrinsic motivation. In a creative activity, children with no-limit or an informational limit spent more free choice time, an indication of high intrinsic motivation, than the children who had controlling limits. When it comes to products, the no-limit condition was superior to controlling condition in terms of creativity ratings. Higher technical quality of the products was evident in the informational limit condition than the controlling condition.

If routines are imposed by others, they tend to hinder creativity because they function as a kind of pressure. Yet, according to Mihályi Csikszentmihalyi, not all routines harm creativity. In fact, some persons work best under pressure. Moreover, time is a function of subjective interpretation, and different people will interpret time periods variously. The subjectivity of time and the relationship between that interpretive tendency and creativity is implied by research on "flow." Flow is characterized by a loss of self and a loss of the awareness of time passing.

The subjectivity of time and a second connection to creativity is suggested by the ability of certain creative persons to look beyond the present. This tendency is epitomized in the "future problem solving" educational program and the "proactive creative work" of some creative persons. Proactive creative efforts may allow us to avoid problems, or solve them when they are minor, rather than solving them when they are no longer deemed unmanageable. One part of the subjectivity of time can be explained by "cognitive style." Impulsivity and reflective cognitive styles have been isolated, and they differ in terms of how much time is required or used by the individual. Perhaps one individual uses a great deal of time because he or she is not really aware of its passing. Indeed, this is one of the basic premises of the concept of flow. To the extent that creative insights are often protracted, impulsivity might decrease the likelihood of creative work.

Attribution of Creativity and Time in Interpersonal Processes

Time is required for some of the social, interpersonal processes that contribute to creative work or are involved in our judgment of it. Many researchers have argued that the attribution of creative ability is most accurate only after a long period has elapsed, ostensibly giving the judges a better perspective. The need for a long-term perspective is evidenced by the changes that sometimes occur in reputations. Rembrandt, for example, was not the most famous artist of his time, but he is now one of the best known of his era. The work of Gregor Mendel was largely overlooked for 50 years.

An issue arises when eminence is defined in terms of social attribution. This brings into question the idea of a creative genius being ahead of his or her time. If creative geniuses are ahead of their time, their genius might not be recognized. Records might not be kept of his or her work and no attention would be given to it. The assumption is that the reputation of creative exceptionality emerges from the social and cultural context. This may occur in two ways. The product may not receive much recognition during the creator's lifetime; or the exceptionality may be recognized during the genius' lifetime but forgotten after his or her death. As a result, necessary resources might not be allocated to the individual because of a lack of appreciation. In this light, the creativity might never develop to the level of exceptional achievement. A second interpersonal issue involves the possibility that immediate temporal constraints may undermine creative work. This was implied earlier in the discussion of task instructions for the assessments of creative potential. It was further intimated by the attributional process that some apply to judgments of creative performance. It may be explained by referring back to the economic theory of creativity, because time is defined as a resource. Time can be invested in training or work. This becomes an interpersonal dynamic when other persons (e.g., parents, teachers or supervisors) decide how much time should be invested.

Culture

Clearly, cultural norms and expectations shape an individual's creativity. Novelty or originality is one of the important criteria. What is original in one culture may not be original in another. People may not think of possible solutions to a problem because they are taboo within their present culture. According to Lubart (1999) Western creativity focuses on innovation, or products. Adults may not consider humor or play as contributions to creative work: work is supposed to be serious rather than fun. Thus, there is often pressure to work quickly and to be productive. It may not be easy to tolerate incubation and appreciate the value of "let it happen" tactics. Time is a valuable commodity and incubation may be a waste of time for some.

On the other hand, Lubart defines Eastern perspectives of creativity with personal fulfillment and the expression of inner essence. In Eastern societies, creativity needs more time, because it is a journey of exploration to the true nature of the self. As opposed to the negative view toward tradition of Western culture, Eastern views of creativity acknowledge tradition. Time is not linear from the Eastern perspective; it is something expected and valuable to have ties with the past. Creativity is an ongoing process of reinterpreting traditions and the nature of the universe.

Another difference between Eastern and Western cultures is the influence of formal education on creativity. In his historiometric studies, Simonton analyzed the differences between Eastern and Western cultures and found that the level of formal education

positively correlates with creativity in Eastern societies. However, spending more time in formal educational institutes may be detrimental in the West where the relationship between the level of formal education and creativity is an inverted U curve.

Conclusion

Time is thus relevant to several cognitive and metacognitive processes that might be involved in some creative thinking. It is related to incubation and necessary for the remote associates that tend to provide original ideas. Time can be used strategically in “let it happen” tactics, and it may be indicative of the investments and intrinsic motivations of creative persons. It should be explicitly deemphasized when using tests of creative potential. The cultural basis of time should be acknowledged, even as specifically associated with creative work, as should the value of time as a resource in most organizational and educational settings.

Time is used in areas of creativity research in addition to that reviewed in the present article. Gudmund Smith, for example, varies the exposure time in his Creative Functioning tests, while Norbert Jaušovec examines heart rates as related to stages in the creative process. The relevance of time is widely recognized and even more varied than the present overview might suggest. Very likely, most or even all of the ways that time influences creative behavior should be qualified. After all, virtually all other influences on creativity show optimal levels. Divergent thinking, for example, often supports creative problem solving, but only up to a point. You can be too divergent (and never bring an idea down to earth to make it useful). You can also be too independent, too conventional and too intrinsically motivated. Again, it may be that all influences on creativity are most effective at an optimal rather than extreme level. Time, then, may also have optima. Just to name one example, incubation may be a good thing for creative thinking, but perhaps only for a period of time and certainly not *ad infinitum*. The same optimization may apply to all temporal influences and correlates.

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Tolerance for Ambiguity

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Introduction

The term tolerance for ambiguity is found in the creativity literature, expressed perhaps as tolerance of ambiguity, tolerance toward ambiguity, tolerance toward ambiguity, ambiguity tolerance, or even tolerance of uncertainty, as a commonly cited trait of the creative personality, both young and old. For example, while drawing attention to the paradoxical nature or antinomies of the creative person, [Runco \(2007, p. 314\)](#), asserted that:

The creative personality can be described with some combination of the following ...: autonomy, flexibility, preference for complexity, openness to experience, sensitivity, playfulness, tolerance of ambiguity, risk taking or risk tolerance, intrinsic motivation, psychological androgyny, self-efficacy, wide interests and curiosity.

In this context, tolerance for ambiguity is generally defined to be a propensity or proclivity to perceive ambiguous situations as desirable ([Budner, 1962](#)). In taxonomies of recurrent attitudes and traits of creative people, tolerance for ambiguity tends to be described as a tolerance of disorder and an attraction to complexity, and it is set alongside other traits such as attraction to the numinous, the mysterious, the asymmetrical and the incongruous.

Historical Development

Originally, tolerance for ambiguity was proposed as the converse of intolerance of ambiguity, a construct that surfaced during research on the authoritarian personality. The construct of the authoritarian personality is clearly a highly relevant and important issue in prejudice and cross-cultural studies, and grew out of work by both Erich Fromm in the 1930s on the authoritarian character, and Abraham Maslow in 1943 on the authoritarian personality. Then, from 1943 until 1950, Theodor Adorno (well known for his contributions to the Frankfurt School), Else Frenkel-Brunswick, Daniel Levinson, and Nevitt Sanford conducted an extensive, long-term, anti-fascist research project, examining the traits of the authoritarian personality and their relationship to the potentially fascistic individual. Their study involved the construction of a series of instruments to measure prejudice, and included an "A-S [for anti-Semitism] Scale", a "PEC [for political-economic conservatism] Scale", and a ranking scale called the "F [for fascist, or for pre-fascist, or for potentially fascist] Scale", which later morphed into the "E [for ethnocentricity] Scale". In 1950, the findings from their search for the fascist personality were published in a monumental and now classic 990-page tome, entitled *The authoritarian personality* ([Adorno et al., 1950](#)).

For part of this research project on the authoritarian personality, Frenkel-Brunswick specifically examined attitudes toward ethnic prejudice, and from the findings published three seminal papers on intolerance for ambiguity ([1948, 1949, 1951](#)). [Frenkel-Brunswick \(1948\)](#) comprised an abstract of her study, reporting that the intolerance of ambiguity variable was a general personality variable foundational for social orientation (p. 268):

The prejudiced are significantly more often given to dichotomous conceptions of the sex-roles, of the parent-child relationship, and of interpersonal relationships in general. They are less permissive and lean toward rigid categorisation of cultural norms. Power-weakness, cleanliness-dirtiness, morality-immorality, conformance-divergence are the dimensions through which people are seen. ... There is sensitivity against qualified as contrasted with unqualified statements and against perceptual ambiguity; a disinclination to think in terms of probability; a comparative inability to abandon mental sets in intellectual tasks, such as solving mathematical problems, after they have lost their appropriateness. (p. 268)

Frenkel-Brunswick carefully laid out the evidence and argument in support of her model of “one of the basic variables in both the emotional and the cognitive orientation of a person toward life and what she [speaking of herself] has suggested be labeled *tolerance* versus *intolerance of ambiguity*” (Frenkel-Brunswick, 1949, p. 113, italics in original).

Her study involved the construction of a series of instruments to measure prejudice and for the assessment of related factors. Initial data were collected from 1,500 American school children aged 11–16 years old; 120 of these children, who represented to Frenkel-Brunswick the extremes of either prejudice or freedom from prejudice, participated in individual interviews and projective tests, and their parents were also interviewed; in addition, about 40 of these children were subjected to further tests of perception and memory. She found that the denial, avoidance, or elimination of ambiguities (often expressed as a distortion of reality) could be understood in terms of a rigid adherence to a norm: “Assumptions once made, no matter how faulty and out of keeping with reality because of neglect of relevant aspects, are repeated over and over again and not corrected in the face of new evidence” (p. 119). She concluded that an intolerance of cognitive ambiguity and a denial of emotional ambivalence were simply different aspects of what appeared to be a fairly coherent characteristic.

Frenkel-Brunswick (1949, p. 141) argued, finally, that “The struggle between these two orientations is basic to our civilization, its individual members display these two patterns in varying proportions and changing configurations.” In the full report on the authoritarian personality Frenkel-Brunswick (Adorno et al., 1950) concluded that:

It is perhaps mainly the readiness to include, accept, and even love differences and diversities, as contrasted with the need to set off clear demarcation lines and to ascertain superiorities and inferiorities, which remains as the most basic distinguishing criterion of the two opposite patterns. (pp. 485–486)

In any case, what clearly remains is a supposedly linear ethnocentricity variable, and a scale that purports to measure this variable. For this variable, ethnic prejudice is set against its purported opposite, which might be termed ethnic unprejudice, and for this variable Frenkel-Brunswick’s (1948, 1949) construct of Intolerance of Ambiguity appears to play a very important if not a central role.

Creativity and Tolerance for Ambiguity

After the report on the authoritarian personality researchers in psychology were quick to apply its findings and methods to areas other than ethnic prejudice. For example, O’Connor (1952) explored the relationship between ethnocentrism, intolerance of ambiguity, and abstract reasoning ability, and found that intolerance of ambiguity was not particularly correlated, one way or another, with abstract, syllogistic reasoning ability.

Then, in an essay on creativity and culture, Stein (1953, p. 312) brought the concept of tolerance for ambiguity into the creativity literature:

The creative person has a lower threshold, or greater sensitivity, for the gaps or the lack of closure that exist in the environment. The sensitivity to these gaps in any one case may stem largely from forces in the environment or from forces in the individual. Associated with this sensitivity is the creative individual’s capacity to *tolerate ambiguity*. By ‘capacity to tolerate ambiguity’ I mean that the individual is capable of existing amidst a state of affairs in which he [or she] does not comprehend all that is going on, but he [or she] continues to effect resolution despite the present lack of homeostasis.

Since then, the term tolerance for ambiguity was included in lists of prerequisites for the creative personality by some writers, for example Carl Rogers. The research support for this inclusion, however, is not so unequivocal. In an early and representative study on characteristics of the creative individual, Guilford et al. (1957), considered non-aptitude traits possibly related to creative performance in the visual arts. Three primary traits of interests that might contribute to different kinds of creative thinking emerged: reflective thinking, rigorous thinking, and autistic thinking (*sic*). They also found a pair of primary interests in aesthetic activities, seen as aesthetic appreciation and as aesthetic expression. Then, using self-inventory scores, a factor analysis found indications of some of the expected variables. Two factors identified were an interest or liking for convergent thinking, and an interest or liking for divergent thinking. A third factor was found but remained elusive and only vaguely identified, although it did appear to be related to an interest in aesthetic activities. A fourth factor was identified, tentatively, as tolerance for ambiguity, which was interpreted to mean a willingness to accept some uncertainty in drawing conclusions and in making decisions, along with a tendency to avoid thinking in rigid terms.

Note that the language used in reporting the findings of the research conducted by Guilford et al. (1957) was vague, and only suggested that tolerance for ambiguity might be a trait of the creative personality. Nevertheless, tolerance for ambiguity is now often referred to as the *sine qua non* of creative achievement, and if a supporting reference is cited (and all too often one is not cited) it tends to be either to Csikszentmihalyi (with a date, and hence with no actual reference), or to Vernon who edited a collection of articles on creativity.

Other studies on the relationship between tolerance of ambiguity and creativity naturally focused on adult creative and intellectual abilities and behaviors:

- From his research involving industrial research chemists, Stein (1963) found that the creative person ‘has a personality structure which may be characterized as an open system with minimal entropy and which is unencumbered by excessive homeostatic

mechanisms' (p. 225), that is, the creative person has a more positive self-image and is able to tolerate the ambiguity that is involved in long-term research.

- [Barron \(1968\)](#) noted that the creative personality was tolerant of other people, although many counter examples may readily be found in the literature.
- In summarizing his research on an eclectic and purposive sample of creative writers, scientists, conservative businessmen, bohemians, and engineering students, [MacKinnon \(1978\)](#) mentioned their general tolerance of other people or tolerance toward other people.
- [Comadena \(1984\)](#) found that ideational fluency during brainstorming sessions was associated with a tolerance of ambiguity.
- [Tegano \(1990\)](#) discovered a positive correlation between creativity and both playfulness and tolerance of ambiguity.
- [Furnham and Avison \(1997\)](#) found that individuals with a preference for surrealistic paintings tended to have a high tolerance of ambiguity, which they saw as an indication of a relationship between tolerance of ambiguity and aesthetic preferences.

Tolerance for Ambiguity and the Creative or Gifted Child

In definitions and models of giftedness, creativity is usually understood to be either a necessary component of giftedness or one of the possible ability domains of giftedness. Lists of characteristics of gifted school students, include components that are similar to lists of characteristics of creative adults.

Research regarding tolerance for ambiguity in the field of creativity and education (that is, the education of the creative child and of the gifted child) appears to have been sparse.

- [Smock's \(1955\)](#) study on complex decision-making and response preservation involved child participants, and found some evidence that anxiety is one of the correlates of tolerance of ambiguity. This study also suggested that the tolerance of ambiguity variable is non-linear, that is, individuals with greater tolerance for ambiguity and individuals with less tolerance for ambiguity may behave in extreme ways at opposite ends of the spectrum.
- [Stoycheva](#) found surprisingly that behaviors related to both tolerance for ambiguity and intolerance for ambiguity were valued by adolescents and positively perceived and encouraged by teachers and parents ([Stoycheva, 2011](#)). She rationalized this equivocal finding by arguing that while following norms, seeking certainty, and avoiding risks may be desirable personal outcomes, so too are experimenting, seeking challenges, and exploring new and uncertain situations.

Conclusion

Since the construct intolerance versus tolerance of ambiguity was first proposed by Frenkel-Brunswik in 1948, there has been sparse research conducted on its applications, in particular with respect to the study of ethnic and national cultures, of marketing, and of organisations, including business management and the armed forces. During this time, the construct has evolved from a negative conception, that is, intolerance of ambiguity, to a positive conception, that is, ambiguity tolerance in its various guises.

For excellent reviews of measures of tolerance for ambiguity, see, in particular, [Furnham's \(1994\)](#) factor analytical study of four tolerance of ambiguity questionnaires, and the extensive review by [Furnham and Marks \(2013\)](#). Here it is interesting to note that Furnham and his colleagues drew attention to a lack of sophistication in the literature about tolerance for ambiguity, and that there is no clear operational definition of the concept and its related forms. In fact, [Adorno et al. \(1950, p. 1\)](#) pre-empted the vagueness of such findings by pointing out clear differences in how the concepts of intolerance for ambiguity and of tolerance for ambiguity are understood:

Individuals who show extreme susceptibility to fascist propaganda have a great deal in common. (They exhibit numerous characteristics that go together to form a *syndrome* although typical variations within this major pattern can be distinguished.) Individuals who are extreme in the opposite direction are much more diverse.

That is, the evidence in support of tolerance of ambiguity as a trait of the adult creative personality is not strong and at best it is equivocal. And the evidence in support of tolerance of ambiguity as a personality trait of the creative child or adolescent (and of the gifted child or adolescent) is weaker still. There may be good and compelling theoretical reasons, and, intuitively, plenty of good common sense, for wanting to make these connections. However, a better understanding of the construct is needed, along with better ways to measure it.

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Tourism

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Introduction

The relationship between travel and creativity has always been very solid. Traveling inspired some of the most remarkable pieces of art and literature, and Gauguin, Picasso, El Greco, Pollock, O’Keeffe, Homer, Goethe, Conrad, Steinbeck, or Hemingway would probably not have produced some of their masterpieces if traveling had not been involved. Likewise, great photographs, films, and many different creative expressions exist thanks to the evocative power of traveling and the contact with the different countries and cultures it conveys.

Accordingly, traveling, and hence tourism, can constitute an important source of creativity but not exclusively reserved for great geniuses such as the examples mentioned earlier. On the contrary, the option to increase creativity through tourism is potentially open to all people who decide to embark on a trip and leave home, ready for a change.

On the other side of the ocean, tourism professionals will be trying to draw on their creative potential and ideas to do their job: to attract more and more tourists and exceed their expectations. However, before proceeding any further, let us clarify what is going to be understood by tourism in these pages.

There are different definitions of tourism that circumscribe it to personal reasons such as recreation, relaxation, and pleasure while other broader definitions extend it to business and professional purposes. In either case, the common denominator is that it entails the movement of people to countries or places outside their usual environment (World Tourism Organization). So here lies some of the keys for creative thinking: this movement brings along change and change, in turn, can facilitate the adoption of new perspectives that can help to ignite the creative process. However, this is not always the case, and while for some people traveling and tourism are stimulating activities that can trigger their creative potential, for others it is a tedious, ordinary, and sometimes stressful part of their lives. In short, not all tourism forms will lead to creativity.

Here the term “tourism” will be used in its broadest sense; namely, the movement of people to other places different from their usual residence, using the commercial and hospitality services provided by the industry (transportation, accommodation, catering, entertainment, activities, and so on). Likewise, in the text we will not make a priori distinction between tourists, travelers, or visitors because although the terms may have many different implications, the significant issue here is the relationship between individuals and creativity without preconceived assumptions.

With the aim of reflecting the connections between tourism and creativity, there have been two basic approaches that summarize the two reasons for the trip: one is the more widely studied view which focuses on the idea that by using creativity individuals,

companies, or destinations can devise new proposals and initiatives aimed at attracting more tourists. At first glance, this could be considered just a greedy marketing strategy. However, creativity can encourage innovation and individual skills as well. This approach is being researched within the field of creative tourism.

The other view, with a significantly lesser number of studies, delves into the idea that tourism, under certain conditions, can constitute a valuable resource to improve people's creativity. Both perspectives will be taken into account. The first part will deal with creative tourism and all the aspects associated with it and the second with the effects that tourism produces on travelers from a creative point of view.

Creative Tourism

The concept emerged in the 1990s with the work of [Pearce and Butler \(1993\)](#) who considered creative tourism as a potential type of tourism. Then, the EUROTEx Project, a cultural tourism development project funded by the European Union (1996–99) ([Richards, 1998](#)), and the first Creative Industries Mapping Documents (1998) opened new ground for the appearance of different perspectives on the subject. In addition to Richard's contributions, especially relevant and influential were the works by [Landry \(2000\)](#) with his creative cities approach, and [Florida \(2002\)](#) who highlighted the emergence of the creative consumer, coined the concept of the creative class, and established the indexes of creativity. Creative cities are characterized by using creativity as a strategic factor for urban development plans and developing the artistic, cultural, and social city life. They constitute a powerful attraction for the creative class, composed of creative people who stimulate innovation and work in the creative sector.

Scholars have offered different definitions of creative tourism that share some common elements, emphasized by [Richards \(2011, p. 1237\)](#): "participative, 'authentic' experiences that allow tourists to develop their creative potential and skills through contact with local people and their culture. This formulation suggests a shift towards active rather than passive forms of consumption, and an emphasis on 'living' or 'intangible' culture rather than static, tangible cultural heritage. The essence of creative tourism seems to lie in activities and experiences related to self-realization and self-expression whereby tourists become co-performers and co-creators as they develop their creative skills."

Creative Tourism and Cultural Tourism

From its very origins, creative tourism has been considered a natural sequel to cultural tourism, which in the last years has been suffering a process of overcrowding, homogenization, imitation, and lack of uniqueness that requires corrective action.

Features such as overdevelopment, undermined value reduced returns, and lack of investments have been associated with the reality of cultural tourism in recent times. As a result, other sorts of more innovative, singular forms of tourism, more difficult to duplicate, have been developed, giving rise to creative tourism initiatives, based on more interactive and authentic experiences, such as arts, crafts, and cookery workshops. It is important to note that creative tourism, though initially an evolution of cultural tourism, has managed to gain its position and become a typology on its own.

One of its main points is the development of the aspects of culture (rituals, social practices, festive events, and so on), offering a new wide range of alternatives for destinations, allowing more local cultural symbols to be shown, shared, and hence, perpetuated. Traditional music and dancing, local food technologies, ethnographic practices, or traditional crafts are examples of the type of experiences that can be enjoyed and shared by tourists and locals. This emphasis on intangible culture resources allows for fresh approaches and opportunities in those places lacking a great monumental heritage. Innovation, creativity, and entrepreneurship can complement or make up for other tangible cultural attractions, generating other products and experiences that can attract more visitors and stimulate both the local economy and the cultural idiosyncrasy of the area.

It is also important to emphasize the need to avoid the standardization of tourism products and concentrate on the individualization of tourism experiences. Creative tourism can be a way of approaching cultural tourism in a different way, paying attention to nontraditional uses of the cultural potential of destinations.

Creativity and Experience: Interaction and Authenticity

Several studies tried to identify the different components of tourism experience and its relationship with creativity ([Hung et al., 2016](#); [Tan et al., 2013](#)). To make a tourist experience affect creative thinking and behavior, it is necessary to fully immerse tourists in some sort of interactive tourism experiences, such as the ones mentioned earlier, that can take place in different dimensions of tourism: entertainment, educational, esthetic, escapist, relaxation, involvement, and pleasure.

In addition to being interactive, experiences require authenticity: tourists need to perceive that every experience they are living is authentic. However, tourism providers have to be especially careful about creating new experiential spaces as they can convey a loss of authenticity.

The genuine preservation of culture and traditions in different populations is a powerful attraction for some tourists who would like to share idiosyncratic practices with the locals/residents in their wish to experience ancestral rites and traditions. This interest is especially important as it can help to revitalize those areas.

A highly significant aspect of creative tourist experiences is that they leave deep impressions on participants and have a profound influence on memories, level of satisfaction, and behavioral intentions (revisit intention and positive word of mouth). Those who

have pleasant memories and are satisfied are more likely to revisit and recommend the destination. This situation is more likely to happen when the process implies that tourists and locals are involved in the creation of the tourism product (cocreation). As a result, the generated creative experiences spark the desire to return to the destination, emphasizing the vital link between creative tourism and visitor loyalty.

Accordingly, to encourage memorability and loyalty, it is especially relevant to provide a high-quality experience, in which visitors are actively involved, participating in the cocreation of stimulating, interesting, and affordable activities (Suhartanto et al., 2019).

The Human Factor

The Tourists: Consumers Versus “Prosumers”

Creative tourists have quite a defined profile that makes them different from conventional tourists. After all, they are in search of experiences in accordance with their personality and their way to view life. They tend to be proactive and friendly, open to diversity, and willing to learn and share but they also avoid mass tourism and value sustainability and social and economic responsibility.

Accordingly, in creative tourism, tourists play a highly participative role, so they are considered in a different way. They possess specific features that make them coproducers of experiences becoming “prosumers” rather than consumers.

A robust link is established between consumers and producers, and the final experience will be the result of their mutual involvement in the activity. Knowledge transfer, participation, and practice are necessary ingredients to carry out the devised tasks. In this view, the collaboration of the tourist is essential. Scholars have analyzed in depth quite a few examples of this type of exchange, ranging from gastronomy, tango, flamenco, or hip-hop tourism to tourist performances in collaborative guided tours. In all of them, the interactions of tourists and providers are essential to generate the final product or activity.

It is important to note that once tourists have the opportunity to be involved in this type of proposals, they frequently lose their interest in conventional ways of traveling and seek to experiment with similar activities.

Creativity in Tourism Providers

Creativity is also considered an essential ingredient for tourism providers with the aim of their getting a better development of the sites, attractions, or destinations.

Considering that cocreation is a crucial element for a creative tourism experience, some researchers have emphasized the fundamental role of tourism providers, who should work on their creative skills consciously. This process is especially important when it is necessary to exploit the intangible value of a resource. A cocreative perspective requires the active participation of tourists with the aim of making an unforgettable and unique experience, so tourism providers should be able to “create” powerful engaging interactive approaches that call for the intimate, personal, and emotional side of tourists.

For this reason, tourism providers should get adequate training to enhance their creative skills and be able to devise cocreative approaches to add additional value to the specific site. Fostering their creativity and getting specific training about how the tourist resources can be exploited through cocreative activities can help promote new business opportunities and get a higher level of satisfaction in tourists through more memorable experiences.

Likewise, in order to facilitate creativity in tourism and hospitality employees, some studies have been developed inside organizations to propose new models based on shared knowledge within an adequate work environment and positive atmosphere (Tsai et al., 2015).

Additionally, providers of creative tourism should be able to stimulate, encourage, and promote those features associated with creative development such as tourist involvement and interactivity with the local culture to learn something new and obtain a unique experience. At the same time, they should try to fulfill tourists’ needs for escapism, show consistent respect, and make visitors feel safe and secure to get the necessary peace of mind to be relaxed.

Some companies and business consultants are devoted to the training of future creative entrepreneurs and tourism professionals, organizing specific courses adapted from innovative methodologies and resources, such as Serious Play, Design Thinking, Business model Canvas, Lean Startup, the Competence wheel, or Binnakle, to name just a few. This sort of training that aims to awaken and foster the combination of creativity and entrepreneurship is especially crucial in the case of creative tourism, as most potential promoters are also small investors with limited business experience.

Creativity Occupations: The Creative Class

Together with tourism promoters and tourists, there is a third group of protagonists who form the human creative tourism triangle chart. These individuals are members of the denominated “creative class” (Florida, 2002), composed of people working in the creative sector. This group feels deeply attracted to places that have a creative atmosphere, contributing, thanks to their presence, to the configuration of even more creative space and image.

The synergies generated by this human force, together with other factors that will be analyzed in what follows, will allow the link between tourism and creativity to form a powerful symbiosis with highly interesting consequences for tourists, promoters, and residents.

Products

The most significant elements that are going to channel new creative thinking and development opportunities are the different activities, resources, spaces, services, and events that the tourism industry will exploit to devise and offer a new product.

When we talk about creative tourism products it is essential to take into account that to be considered creative and effective, the product has to be more than “new.” It has to include the different features we mentioned earlier, namely, learning, emotional involvement, interaction, and cocreation, provided in an authentic atmosphere. The common aim is that the resulting activity becomes a memorable experience for the tourist.

Creative tourism products can entail two different components: tangible resources, which usually involve the implication of manual activities (cooking, handicrafts), versus intangible resources that include the living expressions and traditions inherited from ancestors (rituals, social practices, festive events, and so on) and require the use of different strategies, such as the constructivist ones. These strategies are grounded on the participants’ contextualized active involvement, so knowledge is acquired through personal experiences.

Accordingly, creative tourism proposals will often depend on the ability of a destination to boost added value to their cultural heritage and natural resources to attract visitors. In the case of manual activities, the crafts sector is especially relevant as creativity is required not only to overcome the different problems and limited resources that artists have to face but to design and create products that can be attractive for potential customers. Together with artistic colonies, crafts, and gastronomy, other examples of experiences include perfume making, porcelain painting, dancing, textile art, ceramic production, and so on. These creative skills can constitute a source of tourism development, and local communities can transfer their skills in crafts and design to visitors. Currently, there are lots of different creative tourist products and routes everywhere in the world.

Valuable assets for the creation, promotion, and launching of new products are the essential existing synergies between tourism and the so-called creative industries (advertising, architecture, art, crafts, design, fashion, film, music, performing arts, publishing, software, toys and games, TV and radio, and video games; [DCMS, 1998](#)). Integrating the “products” resulting from the creative industries can enrich tourism experiences, generate tourism demand, develop new creative tourism products, and enhance place quality and attractiveness ([OECD, 2014](#)).

All types of tourism initiatives can develop new creative options that can cause a fundamental change in destinations, even having the power to transform them. Recent examples are experiences based on films, series, music, or gastronomy that share the common aim of offering more interactive approaches.

Together with products, events are highly important resources for creative development everywhere, serving to develop economic and cultural linkages between locations and communities. They offer an excellent opportunity to concentrate on different cooperating creative networks and all the elements present in the tourism industry, providing a perfect connection between creativity and tourism. Sometimes, specific events and festivals of different orientation all over the world can become a symbol around which creativity spans and develops around.

An interesting aspect of events for creative tourism is that the attendees are usually a combination of residents and tourists, so events constitute a perfect context for the interaction between them. From the point of view of creativity, the new trends in event organization are characterized by their innovative and participative orientation. The primary objective is that the staging of the event and the engaging, high involvement activities, leave a memorable and transformational experience for visitors and tourists alike. Events seek change and change triggers creativity.

Events are perfect examples of where to see the overwhelming and stimulating echo of creativity in every part of its development and final representation, for both planners and attendees. Tourists immersed in these integrating and interactive activities will share a very favorable context for creative development.

Locations

Every place has the potential to constitute a creative attraction pole for visitors. Locations have a natural, cultural, and monumental heritage that together with their human capital can join forces to project new specific innovative products, events, and experiences that shape an appealing destination irradiating a unique and special atmosphere.

Creative tourism opens the door to alternative public spaces, different from the most visited landmarks, contributing to revitalizing other parts of the destinations and control overcrowding in emblematic spots.

Cities

With the beginning of the 21st century, several scholars highlighted the strong relationship between creativity and urban contexts for many different reasons ([Laundry, 2000](#); [Florida, 2002](#)). On the one hand, creativity was considered to play a crucial role both for creative industries and society and on the other, it was highlighted that creativity could be fostered, becoming, in this way, an essential ingredient to solve urban problems.

The reason behind this link between creativity and cities lies in different features that characterized urban areas: their dynamic and changeable nature, their significant role for innovation, and their diversity, all factors that are frequently related to creativity. For

some tourists, creativity is more easily perceived in places with a multicultural, diverse, and cosmopolitan atmosphere. Likewise, urban, cosmopolitan areas have also been considered essential poles of attraction for the so-called creative class.

All types of cities can be creative in different areas. Since 2004, there is an initiative promoted by UNESCO (UNESCO's Creative Cities Network) to agglutinate a wide range of cities that are primarily characterized by a distinctive creative profile in various fields: literature, design, crafts and folk art, film, music, media arts, and gastronomy. They claim that they offer great opportunities for cities to draw on collaborative projects to make the most of their creative assets. At present, there are more than 180 creative cities all over the world, classified under the categories mentioned earlier.

Creative tourism offers new possibilities by recovering different areas and resources, making the implied destinations more attractive. Sometimes creative people and clusters settle in neglected parts of cities, changing their physiognomy and atmosphere to become more attractive for new residents and visitors. The fact of being part of the UNESCO network of creative cities can also be a powerful stimulus for the cooperative work of different tourism managers.

Rural Environment

Especially interesting is the view that creative tourism in rural areas is more than a set of new tourist products: there is a revival of the community's social dynamics, traditions, and cultural values. In this scenario, creative tourism can contribute to the development of community-based tourism in two ways: first, it can help to foster local communities' self-confidence and empowerment, and second, it can improve the living conditions and lifestyle of autochthonous populations. It is especially significant that creative tourism can contribute to increasing enthusiasm for intercultural exchange.

The authenticity of rural environments can also attract creative initiatives, such as the settlement of artist colonies that are often transformed into crafts and design centers that become, in turn, an attraction for consumers of creative tourism. In this way, creative tourism promotes rural innovation of spaces and fosters creative job positions.

Rural environments often constitute a sort of Arcadia for people from the creative sector and lifestyle entrepreneurs who have decided to leave the city. In this context, the proliferation of creative clusters has been commonplace. The potential of the rural environment for creative development is such that a wide range of creative tourism initiatives can be found here. Examples such as arts/crafts festivals, master classes, textile crafts, folk art, or workshops are typical in rural areas all over the world.

In addition to the role of human-made creative products, rural areas may include natural resources that serve as a basis for creative proposals, customarily based on effective staging and narration. Sometimes nature itself (unique natural landscapes, wild animals) is marketed as a tourist product, and tourists become the agents of a "dramatized" performance that they could not observe by themselves without the mediation of a tourist product.

However, it is important to note that sometimes, both in the case of cities and rural areas, adversity can trigger creative behavior and strategies. There are different examples of neglected areas of cities that have been drastically transformed due to the colonization of degraded neighborhoods by artists or industrial cities that thanks to creative initiatives have entirely changed their image and projection.

Impact on Destinations

The fact that tourists become proactive agents of tourism experiences contributes to a change in the pace of life and atmosphere of destinations, becoming part of the bustling and stimulating rhythm of cities or the invigorating power of natural and rural environments. They transcend their role of visitors to become part of the community. They absorb knowledge and experiences, but they also leave their imprints behind.

These tourists, very frequently, do not feel like tourists and do not like to be identified as such. They want to be integrated into the destination, sharing as many aspects of the locals' lifestyle as possible and experiencing a sense of authentic immersion. It has been highlighted that this type of "nontourist" prefers to consider that their trips are more an extension of their everyday life than a contrast to it. They are happy to live together with the locals, interacting with them and sharing their daily lives.

This formula is becoming so popular that many new entrepreneurs are creating companies based on the interaction between tourists and locals, with meals in residents' homes, city walks, countryside exploration, and so on. In any case, the features and profile of tourists interested in this kind of interactive, cocreative activities will limit the number of potential participants.

Creative tourism also implies some sort of involvement and engagement that can be very demanding. Accordingly, there is no reason to think that creative tourism can suffer from the adverse effects of mass tourism. Equally, the activities demanded by this type of tourists are not linked to seasonality, so destinations can have visitors all through the year and maintain their authentic atmosphere.

Creative Tourism and Economic Aspects

Tourism is one of the most important industries in many countries, with a very significant impact on many other sectors. As in any other business, one of its main concerns is getting economic benefits, the more, the better. Creative tourism is no exception, and it has been considered a development tool to improve national economies, regions, and cities.

It can have a significant effect on rural areas, and there are initiatives all over the world that have confirmed outstanding results, with essential increases both in tourism visits and revenues. Very frequently, these proposals are organized in creative clusters, making places more appealing to attract visitors and therefore, contributing to the improvement of the local economy.

These types of creative tourism initiatives frequently have a positive impact on the image of regions and cities from many different points of view, so they are frequently supported by the economic development division of the regional or city government. A significant number of cities, regions, countries, and worldwide organizations have laid the foundations for the emergence of new initiatives and the coordination and dissemination of creative development projects.

With the aim of improving the economy in rural areas, some studies emphasize the need not only to plan a well-developed original tourist structure based on authentic experiences to attract visitors but to establish a quality of place perspective to attract permanent residents, specifically the “creative class.” Creative workers can create new businesses and attract new firms to the area, generating more wealth. Sometimes creativity can stimulate local development and entrepreneurial initiatives. It can avoid the exodus of young people, depopulation, and lack of economic resources and become an essential economic driver for the local economy, with an increase of start-ups and spin-offs in creative industries.

Creative tourism approaches can also play a significant role in cities from an economic point of view. Although cities usually have many other interesting attractions for visitors, creative experiences undoubtedly present new options for potential travelers.

The type of business/economic structure that is usually involved in creative approaches is a small-scale tourism business that allows different kinds of entrepreneurs to set up and run their own company.

Especially significant is the case of lifestyle entrepreneurs who base their activity on their hobbies and interests, sharing their knowledge and passion with others. Making huge profits is not their primary concern. Lifestyle motives (living in a specific selected area, being their own boss, or working in something related to their interests) are their motive. Their activity is generally based on different types of creative products and approaches, such as painting or photography holidays, gastronomic experiences, spiritual or “holistic” holidays, and so on.

However, it is also essential to take into account that cultural and creative industries are somewhat vulnerable in economic terms and can suffer quite a lot in economic crisis. For the consumer, creative experiences should be something unique, stimulating, fun, memorable but also affordable.

Effects on Tourists

Effects on Tourists from Promoters' Point of View

As we mentioned earlier, most studies that try to establish the links between creativity and tourism focused on the points of view of tourism industry agents (products, providers, etc.), leaving aside quite often the tourists' views.

A highly relevant element for tourists is the impression left by the different experiences that took place during their trips. The lived episodes that are worth remembering will make tourists long for revisiting those places, motivated by the positive memories.

One of the main concerns of the industry is fostering the tourists' intention to revisit and recommend the destination, and creative tourism can constitute an excellent contribution to achieve this objective. If creative tourism experiences are memorable, tourists will want to repeat the experience and rely on the same service providers.

Different scholars have pointed out the need for more studies on creative tourism that pay attention to the tourists themselves, as very few place them in the dominant role that they should have.

This line of research highlights the need to take into account what tourists want (Tan et al., 2013) and emphasize the importance of the experiences of creative tourists and the influence of these experiences on their memories, satisfaction, and behavioral intentions, such as revisit intention and positive word of mouth (Ali et al., 2016).

The critical issue is getting to know why tourists choose creative tourism products or experiences, although, as we mentioned earlier, there are reasons to think that tourists make this choice in coherence with what they do in their real life.

Can Tourism Improve Creativity?

It is important to note that not all forms of tourism can lead to creative development. On the contrary, for creativity to be triggered, there must be several conditions, based on interactive experiences that are not commonly present in most tourist products. They are normally restricted to specific creative tourism proposals that the active tourist has to search for and engage in. These experiential products, deeply rooted in authenticity, have to imply diversity, cooperation, cocreation, and coperformance.

Research highlighted (Campos et al., 2018) that the process of cocreation before, during, and after the trip is especially satisfying and memorable for tourists. Collaborating with tourism providers to tailor the trip, participating in interactive and creative activities in the chosen destinations, and sharing the experience on return can be excellent allies to foster creativity.

Especially thought-provoking is the idea that the interaction and cooperation with different cultures that tourism induces can lead to creative thinking and behavior. Evidence from studies on multiculturalism suggests that when an individual is immersed in a different cultural context, he or she has a positive attitude toward it and is willing to broaden his or her horizons and experiences; the new surroundings will open up a world full of new perspectives that can positively contribute to trying new ways of thinking and other strategies to solve problems. In a nutshell, multicultural learning can be an excellent ally in creative development, especially when there are different experiences with a wide range of cultures. Although these studies mainly refer to situations

in which people spend some time living in the country, it leaves a door open to consider that something similar may occur on shorter trips when the creative tourist possesses the right attitude to be integrated with a new culture in an interactive way and with an adequate mindset.

Accordingly, the evidence seems to suggest that to widen their creative potential, tourists should seek more than just superficial contact with the other culture, maintain an open mind to experiences, have a positive attitude toward the other cultures, and participate in interactive situations.

However, even if tourists have not been involved in creative tourism experiences, the simple act of traveling can stimulate creative behavior. For many tourists, the change that traveling implies inspires them to transmit it to others using the endless resources that the information and communication technologies (ICT) have placed at our disposal. In this way, they generate different types of digitalized original materials through the web, referred to as tourism-created content. The resulting product can be presented using three different formats: narrative, visual, and audio (Munar, 2011). The relationship between traveling and creative production has existed for a long time. Travelers used to keep a written record of their trips, a diary or travelogue giving way to the origin of a new literary genre, travel literature, back in the 18th century. Just the privileged few who could afford to travel at those times were in a position to write.

Something similar occurred in the production of documentaries, films, video, or photography. Some years ago, technology-supported visual arts were reserved to just a few, but nowadays, ICT have opened sophisticated and accessible possibilities to convey information and manipulate materials, becoming the best ally for creativity development.

From an artistic point of view, more does not mean better, but undoubtedly, thanks to the combination of more accessible ways to travel and almost universal access to the Internet and ICT, the situation has completely changed. Many people can channel both their desire to travel and their creative germ, making it possible to experiment and put into practice ideas that would remain, otherwise, dormant.

Advantages and Limitations

Advantages

In addition to the numerous social, cultural, and economic benefits that can be accrued thanks to the mediation of creativity-based initiatives, as we have seen, the advantages of creative tourism are primarily linked to its unique, authentic character, what makes unlikely that the same activity can be reproduced elsewhere, limiting the appearance of serial reproduction. In this way, its competitive advantage is more achievable and its risk of failure less likely.

On the other hand, tourists can have a completely different experience, having the option of being immersed in the daily life, culture, and traditions of the chosen destination. Likewise, tourists have more contact with locals, establishing an enriching participative interaction between them. In this way, creative tourists can experience the detonation of their creative potential and obtain a feeling of personal fulfillment that will induce them to try to relive the experience.

Limitations

Very often creativity is seen as a marketing strategy, and tourism developers and policymakers can use its current allure to foster projects and initiatives that are not deeply rooted in the real spirit and essence of locations and populations. The hype is such that no in-depth studies are carried out to check and justify the convenience or need for these proposals. In these cases, creativity can become a fake version of some other more genuine enterprises that some try to emulate. It is not a natural consequence of the genuine interests and lifestyles of cities and regions but an external booster provoked by both the media and academics.

This position can lead as well to homogenization, or serial reproduction, mainly caused by artificial actions. It is true that the features of creative tourism and their experiential, interactive facets require some intervention to encourage creative tourists' participation because they are not merely passive consumers but active cocreators.

In addition, several studies (Richards and Wilson, 2007; Dias-Sardinha et al., 2018) have highlighted several barriers to creative development: the shortage of creative skills, the lack of creative investment and audiences, and the cumulative disadvantage of creative locations.

Besides, very often, the lack of specific local policy regarding specific types of heritage and the absence of cross-sectoral collaboration and cooperation constitute a limitation for creative tourism development.

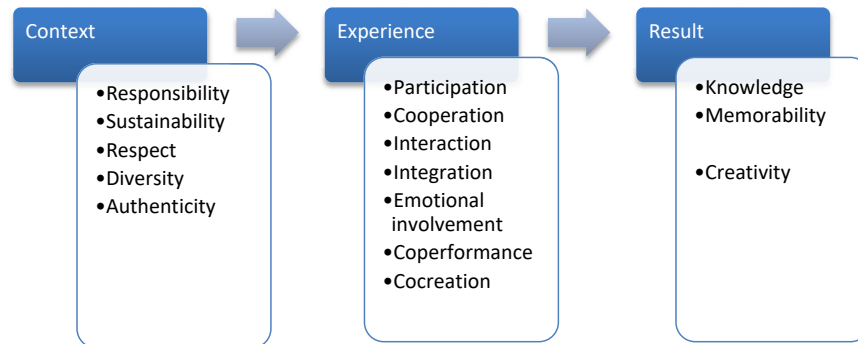
In rural areas, excessive mercantilism can derive in a loss of authenticity and idyllic atmosphere.

Regarding the impact of creative tourism on tourists and locals, very often the tourists do not experience any transformation either from a creative point of view or an intercultural perspective. For locals, sometimes it can even have negative consequences as part of their authenticity can be lost if the emphasis is put on the marketing and commercial side.

Developing a creative product, city, or region is much more than placing the adjective "creative" before the noun because it is fashionable and trendy nowadays. As we saw, a thriving creative project requires a thoughtful analysis of all the elements that come into play to produce something unique, interactive, experiential, and cocreative based on authenticity. In order to achieve this purpose, it is mandatory that both the tangible and intangible aspects of culture are fully respected to be able to genuinely transmit to our descendants what we learned from our ancestors.

Conclusions

A perfect symbiosis between creativity and tourism is necessary to take into account a series of concepts, mentioned throughout the text, that can be considered fundamental for creative development and responsible tourism. The more features the tourism experience includes the more options for creativity to be fostered and increased. They can be recapitulated in the following graphic:



It is also especially significant to take into account that creative tourism does not necessarily imply the development of significant infrastructure or large investments. New projects are frequently based on exploiting the numerous existing authentic resources, applying creative formulas with the aim of attracting both professionals from the creative sector and tourists with an open mind, willing to be integrated into a new stimulating experience that will make them feel fulfilled in the personal and professional arena. In this way creativity dominates the whole process, producing new opportunities for destinations and their residents, promoting the establishment of creative professionals, and awakening and fostering tourists' creative potential.

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Training, Facilitating, Consulting, and Coaching

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Introduction: Creativity as an Applied Science

With the advent of the 21st century, interest in harnessing the practical benefits of creativity has reached heights never seen before. While 20th century proponents of applied creative-thinking methods, pioneers such as [Alex Osborn \(1953\)](#) and [Edward de Bono \(1985\)](#), worked to extol the importance of creativity, today creativity is commonly cited by educational, business and governmental leaders as a crucial workplace skill. Indeed, a recent report produced by such global leaders projected Creativity to be the third most important work skill in the year 2020 (see the World Economic Forum's 2016 report *The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution*). Contrasting the WEF's 2020 list of career skills to their 2015 projections, it is worth noting that Creativity climbed the greatest number of ranks, among all skills, moving from 10th to third most important. The critical role creativity is predicted to play in the workplace is underscored by the fact that the WEF 2020 list includes additional skills that are highly-related to creative thinking (e.g., #1 Complex Problem Solving, #5 Coordinating with Others, #7 Judgment and Decision Making, and #10 Cognitive Flexibility). The WEF is not alone in its clarion call for creativity. Dozens of reports, studies, and books have all reached the same conclusion: creativity is among the top success skills in the 21st century ([Puccio, 2017](#)).

In the 20th century only a few creativity pioneers were proponents for applied creative thinking, yet in the early 21st century there is almost a universal call for creativity. What has fueled this dramatic rise in demand for applied creativity? Simply put, in a world increasingly defined by complexity, uncertainty and volatility, creativity has become a survival skill ([Puccio, 2017](#)). It is now argued that we live in an innovation economy ([Janszen, 2000](#)), and as such the pace of change has expanded at an exponential rate. New technologies, business models, products and services come to fruition and then fade away, faster than ever before. In today's economy, innovation is seen as the route to prosperity and it is widely accepted that creativity is a key catalyst to innovation ([Puccio and Cabra, 2010](#)). To successfully keep pace with change, organizations and societies across the globe are striving to become more innovative; however, innovation occurs only when the creative potential of individuals is allowed to flourish ([Puccio et al., 2018b](#)).

The increased demand for creativity appears to seriously exceed the supply. Findings from a number of studies highlight a skills gap that now exists between the need for creativity in organizations and society as a whole, and the degree to which individuals have been prepared to fully engage in this 21st century ability. To illustrate this point, here are a small number of findings that underscore today's creativity skills gap. Whereas Human Resource managers include creativity among the 14 most important applied skills for new employees, nearly 70% say they don't know how to develop this crucial skill ([Casner-Lotto et al., 2009](#)). Although MBA recruiters identified creative problem solving as one of the top five most desired workplace skills, they also indicated that it's the second most difficult skill to find ([Otani, 2015](#)).

Finally, a series of international surveys carried out by Adobe with students, employees, educators, hiring managers and policy-makers highlighted the creativity skills gap is both considerable and global in scope (see Relevant Websites). With respect to the importance of creativity, 80% of adult respondents felt creativity was crucial to economic growth and 78% believed it was critical to career success. Given this very positive perception of the value associated with creativity, it is regrettable that only 25% of respondents felt they were living up to their creative potential. Sadly, the survey respondents' views of their educational experiences may explain, in part, why they may not be able to fully exercise their creative potential. When asked about the impact of education on creative thinking, 52% of global respondents said their creativity had been stifled by their education (75% in the United States). The need for creativity in an innovation economy, in conjunction with the creativity skills gap, has created growing opportunities for creativity professionals (i.e., experts who are knowledgeable about the nature of creativity and possess the skills to nurture creative talent and outcomes in others). As a consequence, career and commercial opportunities now abound for those professionals who have developed expertise relative to applied creativity.

Professional Roles for Creativity Practitioners

To inform the writers' understanding and personal experiences with the field of applied creativity, Puccio and Switalski surveyed a sample of 50 creativity professionals, mainly based in Europe, North and Central America. They followed up with a focus group aimed at deepening our understanding of the findings that emerged from the survey. Much of the remainder of this entry is informed by the qualitative data gleaned from interactions with these 50 creativity professionals. This review begins by looking at the four professional roles most often assumed by creativity practitioners: Training, Facilitating, Consulting, and Coaching.

Training focuses on the development of creative attitudes, thinking skills and behaviors of the workforce. Creativity training is designed to address the need to develop employees' creative capabilities as applied to their everyday work responsibilities, such as identifying new opportunities, becoming better problem solvers, daring to challenge accepted practices and procedures, and exploring new pathways that lead to innovative outcomes. From the practitioner's standpoint, training encompasses designing and delivering learning sessions that teach people to embrace a mindset that is curious and adaptable to change, as well as to apply and facilitate creative processes, tools and techniques. Training programs are often based on well-known applied creativity methods, such as Creative Problem Solving, Design Thinking, Agile, Lego Serious Play, Lateral Thinking, and Biomimicry. And there is ample evidence to show that creativity training works. In particular, creativity training that is based on cognitive models, like Creative Problem Solving (Puccio et al., 2018a), are among the most effective programs. A meta-analytic analysis of creativity training programs demonstrates that such training has four main areas of impact: divergent thinking, attitudes, problem solving, and creative performance (Scott et al., 2004).

Increasingly creativity training involves the use of technology, teaching people to apply the creativity process on a digital platform, and incorporates the use of graphic facilitation tools. Creativity training programs can range between day-long engagements to several months, and is often supported by individual coaching sessions. Finally, given the transdisciplinary and cross-functional value of creativity, creativity training has been embedded in and used to accentuate training in other subject areas, such as leadership development, project management, sales effectiveness, conflict resolution, support group facilitation, strategic thinking, communication and public speaking, collaboration and team effectiveness, and change management.

Facilitating lies at the core of the services offered by a creativity practitioner. Facilitators are charged with guiding a group through a process designed to enhance collaboration among group members so that the output of their thinking achieves optimal results for the task at hand. To that end, facilitators use their expertise in deliberate creative processes and methods, such as Design Thinking and Creative Problem Solving, to lead a group of individuals through a series of steps designed to produce creative outcomes. When facilitating creative process sessions, creativity facilitators utilize a wide array of creativity tools and techniques that are intended to enhance participants' creative-thinking skills as applied to the content of the meeting. Facilitation services can be applied to a variety of subjects and tasks, such as idea generation sessions, new product or service development, problem solving, strategic planning, process improvement, and vision setting. More broadly, creativity facilitators are often hired simply to guide meetings that improve communication and collaboration within a team. From the client's perspective, facilitation services are results-oriented, i.e., they are expected to attain a desired outcome. From the practitioner's standpoint, facilitation services are process-oriented, i.e., guiding a group's thinking, managing group dynamics, and creating the physical and psychological environment that supports creative thinking and creative behavior.

Consulting represents a more recent expansion in services offered by creativity professionals, as they blend their knowledge and practice of creativity with their experience in the sector of organizational development. Creativity consulting focuses on supporting organizational transformation and change, with particular attention to culture and workplace climate. It responds to the growing interest in building an organizational culture that is innovative and entrepreneurial. The consultative work provided by creativity professionals can also be focused on assisting organizations to be more successful in bringing change initiatives to fruition. Creativity consulting often involves the use of assessment methodologies (i.e., climate surveys, personality type and cognitive style measures, 360 leadership evaluations, one-on-one interviews, focus groups, etc.) to diagnose the current reality of an organization and to identify the desired future state. Based on this data collection and analysis, the creativity consultant designs strategies to achieve the desired outcome and monitors the implementation of the devised plan. Consulting services represent systemic and strategic engagements with organizations and therefore are generally broad in scope and long-lasting. Consulting services typically intertwine with training, coaching, and facilitation services. As such the initiatives led by creativity consultants are deployed across multiple levels and functions within organizations, and are designed to transform individual employees, teams, and the organization. Team effectiveness and leadership development programs are often included in creativity consulting services. Since creativity consultation is strategic in nature, the request for such services generally comes from, and is championed by, senior leaders within organizations.

Coaching is a more recent role adopted by creativity professionals. Building on the mounting success and popularity of coaching services in general, creativity coaching is commonly used to accentuate and support training and organizational development interventions. Coaching engagements are one-on-one programs in which a coach specifically focuses on the learning and professional development goals of an individual. With this end in mind, creativity coaches often serve as facilitators to their clients. In support of this role some coaches actively use creativity processes and methodologies, such as Creative Problem Solving, in their work (Chmielewska and Modrzejewska-Swigulska, 2014). These tools help coaches guide the problem-solving efforts of their clients and, when internalized by clients, enables them to attain greater levels of creative self-efficacy. Creativity coaches use reflective dialog to empower individuals to strengthen their creative mindset, to effectively apply their creative-thinking skills, and to support the

success of organizational change initiatives. A growing trend among creativity coaches is to engage in team coaching. Here creativity professionals support all members of a team as they collectively apply their creative thinking to resolve organizational challenges.

Experienced creativity practitioners tend to play various professional roles, as described above, and thus offer a range of services. As the field of applied creativity has grown, creativity professionals have become more well-rounded and sophisticated, blending creativity practices across fields and integrating creativity approaches to any service they offer. Creativity professionals can follow two alternative career pathways, external or internal to established organizations. A majority of creativity practitioners choose the former, more entrepreneurial career path. External creativity practitioners work as independent contractors who offer their services to multiple clients. They may work independently within a network of colleagues or in relatively small-size consulting firms.

Focus group findings reinforced the fact that as the field of applied creativity matures there is a corresponding increase in the number of creativity professionals who work within established organizations. With competitive pressures forcing corporations to become more innovative, these internal roles are mainly found in the for-profit sector. However, some not-for-profit and educational organizations have created professional roles for creativity practitioners. Generally, internal creativity professionals either have part-time or full-time job responsibilities in work units that serve an innovation function or in more traditional departments, such as learning and development. Internal creativity professionals provide a range of services, such as the aforementioned skills of training, facilitating, consulting, and coaching, but under the umbrella of a single organization.

Becoming a creativity professional is the result of a deliberate approach that requires considerable investment of energy, time, and money. Many of the practitioners surveyed pursued a formal accreditation process through master's degree programs or certificate programs granted by established academic institution. Others sought long-term training programs that require the participant to follow a multi-level learning pathway and demonstrate the acquisition of facilitation, training or coaching skills. Such programs typically provide certification from associations or institutes with expertise in the fields of coaching, creativity, and facilitation. Most of the practitioners surveyed engaged in ongoing professional development activities. For instance, many reported regularly attending creativity conferences where they have the opportunity to meet and network with their colleagues, broaden their toolkit, and deepen their skillset. Additionally, many creativity professionals attend programs that certify the use of assessment methodologies, such as inventories that measure personality type, cognitive style, psychological climate, and emotional intelligence. Finally, most creativity professionals continue to expand their knowledge base and tool kit by learning and applying new approaches to applied creativity as they emerge.

Occupational Description and Benefits of Being a Creativity Practitioner

Data gathered from the survey of 50 creativity practitioners confirms that the majority were self-employed (71%) and dedicated a high percentage of their time (75%–100%) to their work as creativity professionals. The most common job titles used to describe their work were 'Creativity Facilitator' and 'Innovation Consultant'. The combination of words selected for their job titles is informative. For instance, the wide adoption of the term Creativity Facilitator provides a clear indication of the ways in which creativity practices have been integrated into the broader category of facilitation work (Schwarz, 1994). Those who serve as Creativity Facilitators are focused on leading process engagements for groups. In contrast, the consultative role is mostly associated with the word Innovation. Here, the creativity professional guides a transformative process to achieve innovative outcomes that respond to an organization's overarching strategy.

Over the years, the use of the word Creativity seems to have encountered broader acceptance in the business world. Nevertheless, most clients tend to show a preference for the word Innovation, which better aligns with their expectations for tangible results to be derived from the services provided by creativity professionals. Thus, regardless of the job title adopted by creativity practitioners, the sample of creativity professionals indicated that they often use the word Innovation in their discussions and proposals when positioning their services to prospective clients. As one participant in the focus group pointed out, "Clients care about the outcome, they do not ask for creativity, they ask for effective problem solving, change, and innovative results."

The number of clients served per year by a creativity professional, one working independently or in a small consulting firm, can range from a few (up to 5) to many (more than 15). The survey of creativity professionals indicated that the number of clients served was not related to years of experience. Rather, it was more likely to be contingent upon the type of services provided by the practitioner (i.e., short-term training and facilitation services versus long-term consulting and coaching engagements). That said, experience in the field predicted the amount of money earned for creativity services. Professionals with over 10 years of experience report charging daily rates above \$4000, while practitioners with less than 10 years of experience were more likely to set their daily rate up to a maximum of \$3000. When it comes to fees for services, geographical location seemed to play a role as well, with creativity professionals in North America reporting higher rates than their counterparts in Europe and Central America. This geographical difference may reflect the fact that creativity professionals in North America benefit from a more competitive and mature market which allows experienced professionals to garner greater compensation for their services.

Beyond monetary rewards, respondents emphasized two main benefits associated with their work as creativity professionals: personal satisfaction with the nature of the work itself and the sense that their work has a positive impact on others. People who work as creativity professionals share a great passion for their careers which translates into high levels of joy and fulfillment. This sense of satisfaction was accentuated by the second benefit associated with the work carried out by creativity professionals, which is the sense that they assist individuals, teams, and organizations achieve meaningful goals. Creativity professionals take pride in the fact that through their work they help others achieve positive change, both at individual and organizational levels.

A participant in the focus group summarized the creativity professional's sense of accomplishment by saying, "Creativity is a life skill that has profound influence on people's lives. The impact we have working with people might go beyond the results achieved at work. It can spread to their personal lives and positively affect their family and the community they live in."

Future Trends

The future for creativity professionals looks bright. As the world enters a fourth industrial revolution, with artificial intelligence and other forms of technology playing even greater roles in personal and professional lives, the demand for creativity skills is likely to grow. With that in mind, there are at least four important future trends that are likely to influence, and potentially expand, the kind of work carried out by creativity professionals.

First, the field of creativity studies is transdisciplinary in nature, and thus it is expected that creativity professionals will find even greater opportunities to blend creativity practices into a wider array of subjects, functions, and fields. No longer is creativity simply associated with the arts or with the R&D function found in organizations. As the National Center on Education and the Economy (2008) reported, "Creativity, innovation, and flexibility will not be the special province of an elite. It will be demanded of virtually everyone who is making a decent living, from graphic artists to assembly line workers, from insurance brokers to home builders" (p. 25). Given the broad implications and applications of creativity, it is likely that future creativity professionals will provide their services to an ever-expanding set of markets and audiences.

Second, there is a movement towards greater levels of co-creation. These are collaborative processes in which organizations, both for-profit and not-for-profit, partner with end users, consumers, and stakeholders to co-develop creative solutions. By nature, these collaborative processes are highly complex as they bring together individuals with diverse expertise, perspectives, needs, and expectations. It is likely that creativity professionals will be in a position to enhance the effectiveness and outcomes of co-creative initiatives by providing training, facilitation, consulting, and coaching services.

Third, employee engagement represents an area of growing concern among organizations. At the same time, there is clear and compelling evidence that allowing employees to use their creative capacities at work improves intrinsic motivation and satisfaction (Amabile and Kramer, 2011). Given this link, it would seem that creativity professionals might be able to support organizational development initiatives aimed at improving engagement by drawing on the creative talents of all employees, not just those in traditional innovation functions. This emphasis on creating work situations that allow for greater levels of creativity may become more important as the workforce is filled by members of Generation Y and Z. Both generations have been described as being more independent-minded and entrepreneurial than past generations.

Finally, the nature of leadership is determined by the context, and in a complex and fast changing world it may be time for a new kind of leadership to emerge – Creative Leadership (Puccio et al., 2017). Creative Leaders are those individuals who engage their own and others' creative-thinking skills to drive organizational change. Furthermore, by modeling the way Creative Leaders foster work environments that support creative behavior and innovative thinking. The relevance of creativity to leadership was highlighted by a 2010 IBM study of more than 1500 executives. This global study of private and public sector leaders produced the resounding conclusion that creativity is the most important leadership skill going forward. To build organizations that are truly innovative, and not to simply play lip service to innovation, it will be imperative for leaders to adopt more creative attitudes and skills. Here creativity professionals can play a crucial role in developing such future leaders and leaders of the future.

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Transforming Illness and Visual Art[☆]

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The Transforming Illness

Nietzsche's phrase "What does not destroy me, makes me stronger" is evident in the transformational power of major illness. Throughout the centuries visual artists of diverse backgrounds have used creativity to turn poor physical health into a transforming illness, an experience that alters both their lives and their work. There are as many types of transforming illnesses as there are people who have them. Artists have used conditions such as cancer, AIDS, arthritis, quadriplegia, learning disorders, vision problems, deafness, and the aftermath of serious accidents as opportunities for self evolution (Zausner, 2016; Sandblom, 1996). A transforming illness may be an acute episode or a chronic condition, yet whenever it appears, life takes a new trajectory and things are never the same.

Transformation occurs through an interface between an illness and a person's creative response to the illness, with specific aspects of the physical condition influencing both the creative process and the art produced. Some individuals have become eminent artists after a major illness while those that were already practicing professionals have had their way of working altered and their art deepened and changed. The transforming illness can occur at any age from the beginning of life to its end and may happen more than once. By using creativity and physical illness as a combined impetus for transformation, artists can alter their personal experience, self-expression, and ultimately cultural history.

Aspects of the Transforming Illness

There are multiple aspects to the transforming illness such as resilience, using creativity as coping mechanism, self efficacy, mastery, compensation, and the experience of flow. Using a debilitating physical condition to improve both your life and work is an example of resilient behavior. Resilience is the capacity to bounce back from setbacks and adapt to events in life that are neither comfortable nor planned. Artists will often use creativity as a coping mechanism during illness to manage stress. Our minds can generally focus on only one thing at a time, which makes creativity an excellent coping mechanism during illness because it can distract a sick person from physical discomfort by redirecting attention toward a creative activity. The folk artist Maud Lewis (Canadian, 1903–70), who is the subject of the 2016 biographical film *Maudie*, had a lifetime of pain from severe juvenile rheumatoid arthritis. Yet she spoke about her art as a distraction from pain saying, "As long as I've got a brush in front of me, I'm all right." Arthritis became a transforming illness in Lewis' childhood because she turned to art to pass the time when poor health kept her home from school. Despite severely limited use of her hands, Lewis became a professional artist. Preferring to use her right hand to paint even though her left hand was less affected by arthritis, Lewis propped up her right hand with her left one to keep working.

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The distraction that artists experience during creativity is explained through what the psychologist Mihaly Csikszentmihalyi (2013) describes as a time of flow. In this enjoyable state where self-consciousness fades away, people can become involved in a task to the extent that they have a diminished awareness of stimuli from the outside world. The positive feeling engendered during a state of flow acts to further whatever activity is generating the experience. When creativity produces the state of flow, it becomes an impetus to continue making art.

The creative expression that takes place during illness can also be a welcome experience of self efficacy and mastery, imparting a feeling of strength that counteracts the weakness stemming from physical problems. In addition, artists have used the subject matter in their work as compensation for activities they feel have been denied them because of illness. After a debilitating traffic accident that required a long convalescence, the painter Frida Kahlo (Mexican, 1907–54) said, “As the accident changed my path, many things prevented me from fulfilling the desires which everyone considers normal, and to me nothing seemed more normal than to paint what had not been fulfilled.”

Making art during illness can become a healing experience, which like the state of flow, further encourages the activity. The French painter Henri Matisse believed that not only was creativity healing but so were its products. He would hang his work around the beds of sick friends because he was convinced the bright colors would help them feel better as they did for him when he was sick.

The Early Transforming Illness

Many eminent artists began their careers as the result of an early illness. Some conditions were present at birth while others were contracted. Yet in all cases the artists used creativity to pass the time when they were sick. The early transforming illness differs from its occurrence in adulthood because it is necessary for the child to have at least one attentive caregiver. In examining the lives of resilient children who came from backgrounds of hardship, the psychologists Emmy Werner and Ruth Smith found each resilient child had at least one nurturing relationship and that this supportive relationship was life changing for them. For young artists, the caregiver was not only nurturing but also encouraged the child’s creativity and provided art supplies, which can be pivotal in an early transforming illness.

When Andy Warhol (American, 1928–87) became sick at age eight the art supplies his family gave him during his long months of convalescence shaped the work he would create as an adult. Warhol had rheumatic fever which progressed to chorea, an illness of the central nervous system that caused violent tremors. Although they were of very modest means, his mother believed that creativity would help him recover. She gave him coloring books, comic books, paper doll cutouts, and movie magazines while his brother Paul gave him a camera and taught him art techniques. As an adult, Warhol’s paintings had black outlines and swatches of color like coloring books; he made images of movie stars and comic book characters; the camera became central to his work, and he used paper doll cutouts in his early graphic design.

At age eighteen, Frida Kahlo (Mexican, 1907–54) was severely injured in a traffic accident. Incapacitated for months, her mother had a carpenter build an easel for her to use in bed and her father, a photographer and amateur artist, gave her his oil paints. Kahlo had been a pre-med student until she began making art during her convalescence. “Instead of studying to become a doctor,” she stated, “And without paying much attention, I began to paint.” Kahlo had a prior transforming illness at age seven when she contracted polio and began to draw. Her father encouraged her talent and taught her how to use a camera. Even though Kahlo sketched constantly and took art lessons she planned on a career in medicine until the traffic accident altered her life.

Mobility problems early in life also turned Henri de Toulouse-Lautrec (French, 1864–1901) to a career in art. Research suggests he had pycnodysostosis, an inherited condition producing brittle bones that heal poorly, problems with walking, and dwarfism. Unable to be athletic like his relatives, Lautrec was instead a periodic invalid throughout his early years. Then his condition worsened because of two falls he sustained as a teenager that broke his leg bones. Lautrec’s uncle, an amateur artist, had given him art lessons since early childhood and during his convalescence from the accidents he focused on creativity. Acknowledging the role of illness in his life, Lautrec insisted, “One thing is certain, if my legs had been a bit longer I would never have become a painter.”

Parental Pressure, Illness, and Careers in Art

For some individuals, whose families wanted them to follow more secure and established professions, it was an illness in childhood and young adulthood that halted parental pressure and allowed them to become artists. The desire to see a sick child recover was paramount to the caregivers, even if it meant that the young person would choose a less secure vocation. When Lawrence Alma-Tadema (English born in Holland, 1836–1912) developed tuberculosis as a boy, his family believed he had not long to live. In response they allowed him to stop preparing for a career in law and take art lessons. Alma-Tadema’s health recovered, and he became a professional painter. George Tooker (American, b.1920), who had suffered from ulcerative colitis and a chronically inflamed appendix since childhood, acceded to family pressure to have a career in finance although he wanted to be an artist. When Tooker’s intestinal problems became extremely severe in his early twenties, his parents relented, and he began a career in art.

As a teenager, Henry Ossawa Tanner (American 1859–1937) knew he wanted to be an artist but his family pressured him to be a businessman. He had been a sickly child and the stress of painting at home while going to work severely compromised his health. Tanner’s parents, fearing he might die, gave in and permitted him to become an artist. Tanner had a second transforming illness in his early twenties. As a young artist painting in Paris, he contracted typhoid fever and went home to Philadelphia to recuperate. It

was on this trip home that Tanner reconnected with his African-American heritage and celebrated his ethnicity in the best-known paintings of his career. Although all of these men were very sickly as children, they found art to be healing and all three of them lived long lives.

Eye Problems in Childhood and Their Influence on Art

It may appear paradoxical that an individual with poor eyesight would decide upon a career as a visual artist, yet this has happened repeatedly and with a variety of visual impairments. When the visual condition occurs in childhood, then as with other early illnesses, it is important to have an encouraging and nurturing caregiver, one who focuses on the young person's desire for creativity rather than on the presence of a visual disorder. Albert Pinkham Ryder (American, 1847–1917) had the good fortune to have such a caretaker in his father. When Ryder developed a severe inflammation of both eyes in response to a childhood vaccination, his father, knowing that his son liked to draw, gave him art supplies. The gift changed Ryder's life. He said, "When my father placed a box of colors and brushes in my hands and I stood before my easel with its square of stretched canvas, I realized that I had in my possession the wherewith to create a masterpiece that would live throughout the coming ages." Ryder's eyesight remained problematic throughout his life. Unable to see fine lines, he used broad areas of color and painted from his imagination. Ryder's poor vision created strength in his art.

When Matthew Brady (American, c.1823–96) was a teenager, he also had a severe eye inflammation and turned to art. While making a trip to find medical care, Brady met the painter William Page, who encouraged the boy and gave him art lessons. Later, in his twenties, Brady changed from painting to photography. With diminished sight he needed assistance to focus the camera and adjust the dials, but it was he, who arranged the poses, composition, and lighting. Although Brady is well known for his portraits of Abraham Lincoln, his most famous photographs are of the Civil War. While both Ryder and Brady had lifelong vision difficulties, sometimes an eyesight correction can turn a child to art.

Nell Blaine (American 1922–96) said two things influenced her to become a painter, "One was making art when I was a sick child in bed and the other was the improvement in my eyesight from glasses and operations." When Blaine was finally able to see well, the world looked so beautiful to her that it became the subject of her art for the rest of her life. Sometimes eyeglasses can only give a partial correction as they do with Raymond Hu (American, b. 1977), who works with his eyes just inches away from the paper. Yet with parental encouragement, art lessons, and supplies, Hu started making art as a teenager and continues working today. Despite the poor fine motor control that is associated with his condition of Down syndrome, Hu perseveres and forged a new watercolor technique combining Asian and Western elements.

Learning Difficulties: Dyslexia, Attention Deficit Disorder, and Prosopagnosia

Learning disorders have also turned individuals to art. They are widespread, affecting about 10 to 30 percent of the population with dyslexia being the most prevalent. Dyslexia, which is usually inherited, is noted by problems with reading, spelling, and writing. Now a recognized learning problem, people with dyslexia in the past were often considered to be less intelligent even though some of them like Leonardo da Vinci (Italian, 1452–1519) were geniuses. People with dyslexia often have difficulty learning a foreign language and Leonardo, who appears to have a type of dyslexia known as surface dysgraphia, could never master Latin. As a result, he could not enter his father's profession of a notary nor attend university where classes were given in Latin. Instead, Leonardo decided he would become a "disciple of experience" and do his own empirical research rather than quoting the work of others. Focusing his keen mind on the natural world, he recorded notebooks filled with scientific observations (Vasari, 2008). Leonardo also became an artist, a profession where education was not written in Latin but given orally in Italian.

Leonardo also appears to have a mixed form of attention deficit disorder that contains both daydreaming and restlessness as well as the ability to hyperfocus, which is the capacity to concentrate for an extended period. While Leonardo's restlessness often prevented him from finishing long term projects, it helped him create short term works such as drawings. By the end of his life, Leonardo made over four thousand drawings, a number four times greater than any other individual of his time. Leonardo employed his ability to hyperfocus during the long hours he is recorded as working on his art. He used his propensity to daydream to create inventions such as his machines. When assembled over five hundred years later from Leonardo's original drawings, these machines work perfectly.

The sculptor Auguste Rodin (French, 1840–1917) also had dyslexia. His parents wanted Rodin to have a career in the professions or civil service. Although Rodin eventually learned to read, he was unable to master Latin, spelling, or mathematics. Realizing this, his parents allowed him to study art. Both Rosa Bonheur (French, 1822–99) and Pablo Picasso (Spanish, lived in France, 1881–1973) had dyslexia. Yet Bonheur and Picasso may have become artists even without learning disorders because their fathers were professional painters who gave them art lessons from an early age.

Dyslexia has also affected the career choices of contemporary artists. Greystone Elizabeth Abbott (American, b. 1959) became a ceramic artist in response to an academic impediment in college. Yet the dyslexia that spurred her career change brought out a connection to her Native American heritage that had lain dormant until she began decorating her ceramics with tribal imagery. Chuck Close (American, b. 1940), who has attention deficit disorder and dyslexia, received art lessons in childhood and insists that

"Art saved my life." In response to being considered an unintelligent, inattentive, and lazy student at school, Chuck Close worked long hours teaching himself to read. The discipline he developed as a child shape his disciplined work habits as a professional artist. Close also has prosopagnosia, which is an inability to recognize faces. People with prosopagnosia, also called face blindness, cannot see a face in its entirety but instead comprehend the face as comprised of many separate bits of information, which when combined create their perception of a face. Close's work is completely comprised of faces created from separate small bits of information that the viewer combines into a whole image, thus seeing a face prosopagnosically as does Chuck Close.

Adult Onset of Illness

When physical illness occurs in adulthood, either acute or chronic, it can change an established artist's way of working and may also bring benefits from what may have initially appeared to be a disaster. During the winter of 1894–95 Odilon Redon (French, 1840–1916) became ill and described his condition as "being struck by exhaustion like a thunderbolt." Prior to that time Redon had focused on black and white work but by the middle 1890's he had begun to use color. After 1895 color work became his dominant form of expression, and Redon stated, "I am leaving black behind me." Consuelo Gonzalez Amezcua (American born in Mexico, 1903–75) also had a transforming illness in adulthood. Amezcua was a sculptor who worked in limestone but inhaling the rock dust as she carved left her with breathing problems. Forced to change mediums, Amezcua started drawing and found she had a gift for color.

The ceramic artist David Drake (American, 1800–c.1870) was also a poet. Known as "Dave," he had a transforming illness while a slave in South Carolina. A master potter who created large clay vessels that were used to store food before refrigeration, Dave was the first African American ceramic artist to sign his vessels and the first to write poems on them. Sometime before 1857, Dave lost a leg, making it impossible for him to stand and kick the potter's wheel he used to shape his clay. Determined to keep working, Dave had Harry Simkins, a slave whose arms were disabled, kick the wheel for him. By 1859 Dave Drake was making the largest ceramic works of his life.

When the kimono designer Itchiku Kubota (Japanese, b. 1917) was having a second exhibition of his art at age sixty, he contracted acute hepatitis. While in the hospital Kubota thought about his work and decided to develop a new style of kimono design combining ancient Japanese techniques with French Impressionism and scenes of nature. Kubota, who became very successful, spoke about the influence of having hepatitis saying, "This was the time of deepest import in my life as an artist." Pierre-Auguste Renoir (French, 1841–1919) started to develop rheumatoid arthritis at age fifty-six and despite his efforts at exercise, the illness progressed. Sitting in a wheelchair with swollen immobile fingers, Renoir continued to work. With small gauze pouches to hold his brushes, the artist moved his arms rather than his wrists to make art. His son Jean Renoir admired his father's determination and said, "The more intolerable his suffering became, the more he painted."

Creativity in Response to Cancer

One of the most prevalent illnesses in adulthood is cancer. Currently it is estimated that about one out of every three women and one out of every two men will develop this illness during their lifetime. Like the general population, artists get a variety of cancers but for the following individuals, the illness becomes a challenge that they face with creativity in a variety of ways. Some artists change their way of working or use the work specifically to address their emotional response to illness, while others like Vincent Desiderio (American, b. 1955) find that having been sick has strengthened them emotionally. Desiderio, who had an aggressive type of nasal pharyngeal cancer, says that the ordeal of illness and treatment with chemotherapy and radiation was grueling but it changed him. He states he now lives in the present moment and has developed greater internal strength, saying he no longer requires "validation from outside."

Although they had different types of cancer, Darcy Lynn, Dan Savage, and Nancy Fried used art to depict their psychological response to illness and treatment to manage the stress. The images they produced were often graphic depictions of medical procedures, shunts, vomiting, and breast removal that also showed their emotional anguish. After they recovered, all three individuals who remain well today used the art they created during illness to give hope to others who were sick. In 1991 when Darcy Lynn (American, b. 1956) was diagnosed with Stage IV immunoblastic lymphoma, a non-Hodgkin lymphoma, she documented her entire treatment through a series of paintings and drawings. After her recovery Lynn gave lectures on the role of creativity in healing to medical personnel saying, "I fought illness with the best weapon I had – my art."

Dan Savage (English, b. 1982), who was twenty years old when he was diagnosed with an aggressive form of testicular cancer, also depicted his treatment. Creating daily images of medical procedures and his response to them, Savage says, "I accepted it and used it for inspiration." After his recovery, Savage became a public speaker to emphasize the necessity of early detection and treatment, saying "I show there is life after cancer." Nancy Fried (American, b. 1949) had cancer four times during the years of 1986 to 1990. She had three separate types of breast cancer and cancer of the appendix. In response she began making sculptures of her ordeal. She shows herself with one breast after a mastectomy, having severe burns from radiation, and depicts her agony about being sick. Her sculptures became widely known. Fried, who did not have breast reconstruction and refuses to wear a breast prosthesis, openly presents herself as a one breasted woman saying, "By making something private public, you find you aren't the only one."

Artists With AIDS

AIDS (Acquired immunodeficiency Syndrome) is a pandemic but nowhere it is more prevalent than in Africa. Thirteen South African women, members of the Bambanani Women's Group: Babalwa Cekiso, Thobani, Nomawethu, Victoria, Noloyiso, Non-dumiso Hlwele, Thozama, Bongwiwe, Bulelwa Nokwe, Ntombizodwa Somlayi, Ncedeka, Maria, and Nomonde, who contracted AIDS, made art in response to their illness. Their creativity was part of the Memory Box Project from the University of Cape Town. It was originally intended to be expressive arts therapy for dying individuals to help alleviate stress and build a legacy to leave their children. Then with the introduction of ARVs (anti-retroviral medication) the women started to recover. Despite the sometimes violent prejudice against people who are HIV positive, the women have used their art as a political statement to highlight the importance of extending medical care to other low income individuals with AIDS. They also want to encourage those living with HIV saying, "We want to teach people living with HIV how to live with HIV. We want people outside to know that it is not the end of the world."

Keith Haring (American, 1958–90) also made a political statement about having AIDS. A very successful artist with a strong interest in human rights, Haring created posters about AIDS awareness and established a foundation to continue his work. It is the Keith Haring Foundation which carries on his commitment to assist both AIDS organizations and children. John Dugdale (American, b. 1960) was a commercial photographer who used AIDS to change careers and do the fine art photography he always wanted. Despite the multiple opportunistic infections associated with AIDS that caused him to lose half of his hearing and eventually all his eyesight, Dugdale, who achieved success as a fine art photographer, insists that, "In illness there is an unbelievable opportunity for freedom and change."

Color Vision Deficiency and Its Influence on Art

One of the most common visual impairments is color vision deficiency, also known as color blindness. Usually an inherited condition, it affects one in ten men and one in two hundred women. The degree of impairment can range from a slight inability to see colors to a profound lack of color discrimination. Although people with color vision deficiency have problems perceiving color, they have an enhanced ability to distinguish gradations of light and dark along with an acute perception of textures and patterns. Color vision deficient artists use this acuity in the gradations of light and dark that empower their work.

One of the most famous artists in Western culture, Rembrandt Harmenszoon van Rijn (Dutch, 1603–69), is believed to be color vision deficient. A. Hyatt Mayor, a curator at the Metropolitan Museum of Art, who was the first to recognize this in Rembrandt's work, also noted that Rembrandt's difficulty in perceiving colors gave him an increased sensitivity to tones of light and dark. He said of Rembrandt that "seeing the world more or less in browns freed him to calibrate luminosity with a delicacy as expressive as any palette of colors." Color vision deficiency also helped Rembrandt with his etchings, which was a black and white medium in the 17th century.

Although it is unusual to find a female artist with color vision deficiency, Kaethe Kollwitz (German, 1867–1945) appears to have this condition. Kollwitz, who showed talent at an early age and wanted to be a painter, realized in art school that her color perception was flawed. She said, "In the painting class I made no progress. Color was my stumbling block." In response, Kollwitz stopped making oil paintings and focused on black and white and brown and white imagery in etchings, drawings, and lithographs. She also turned to sculpture, another medium without color in which she could excel. Paulanship (American, 1885–1966) also had color vision deficiency and changed to sculpture after difficulties with color in his paintings. Charles Meryon (French, 1821–68) was another artist with color vision deficiency who stopped painting and achieved success with his black and white etchings.

Lack of color in an artist's work cannot be used as the sole criteria to assess a person's level of color vision. Odilon Redon and Chuck Close worked almost exclusively in black and white for the first half of their careers before going on to become major colorists. Caravaggio (Italian, 1573–1610), born Michelangelo Merisi, showed an excellent sense of color in his early work but preferred a reduced palette emphasizing light and dark in his later paintings.

Artists With Macular Degeneration

Macular degeneration, which is a disease of the retina, is one of the most common causes of vision loss in older adults. In this illness, the macula, which is the central part of the retina, becomes damaged leaving the affected individual with only peripheral vision. Although this illness usually found in individuals over fifty-five, Edgar Degas (French 1834–1917) had his first symptom at thirty-six. The condition, which began in his right eye, eventually affected his left eye as well. Even without central vision, Degas was determined to work. Unable to stand the glare of the sun, Degas painted indoors, creating interior scenes, portraits, and images of ballet dancers. When his eyesight deteriorated so that he could no longer see the fine lines his brush made with oil paint, Degas changed to pastels where the thick chalk lines were easier to see. These pastels are his most popular works. As his vision worsened and Degas could no longer see the chalk lines, he turned to sculpture, using his hands to help his failing eyes in a determination to remain creative.

For most of her life Georgia O'Keeffe (American, 1887–1986) had excellent vision but in her later years, she developed wet macular degeneration in both eyes along with a rupture of capillaries in the retina of her left eye. Faced with diminishing vision, O'Keeffe started to simplify her forms. She also worked from photographs and from her memory saying, "You paint from your subject, not what you see." For a while O'Keeffe, like Degas, turned to sculpture, but she returned to painting, stating that it was central to her life.

Deafness and Art

Deafness, which is a widespread condition, can be an early influence toward a career in art (Sonnenstrahl, 2003). It may happen when deaf children use art as a means of communication with their hearing parents as it did with John Lewis Clarke, Ann Silver, and Harry R. Williams. When John Lewis Clarke (American, 1881–1970) was three, he became deaf from scarlet fever. As a boy who was unable to speak, he used clay from the Montana riverbanks near his home to sculpt animals as a way of telling his parents what he had seen that day. Clarke, who became a sculptor specializing in animals, eventually learned to sign in two languages, his Native American Blackfoot sign language and the ASL (American Sign Language) that he learned in schools for the deaf. Ann Silver (American, b. 1949), who was born deaf, also used art in childhood as a way of communicating with her hearing family. A professional artist, Silver still uses art as communication but now it is to promote deaf culture. Harry R. Williams (American, 1948–91) was eighteen months old when he lost his hearing after a reaction to the antibiotic streptomycin. At age four Williams began drawing to communicate with his hearing parents and as an adult, he became famous in the deaf community for his exquisitely drawn symbolist paintings.

Perhaps the best-known artist with a hearing problem is Francisco Goya (Spanish, 1746–1828, also known as Francisco de Goya y Lucientes). In 1792 Goya lost his hearing after a severe illness that kept him incapacitated for months. Goya's precise diagnosis is unknown but after becoming deaf his art transformed and his production increased. Goya began his career as a painter of colorful canvases with scenes of pleasant pastimes but after losing his hearing his work became darker, more structured, and filled with political and psychological content. After his illness, Goya turned into a romantic painter and became a precursor of modern art.

Accidents and Their Legacy in Art

Creativity that starts during convalescence from serious accidents may begin a career in art as it did for David Cox and Frank Day. David Cox (English, 1783–1859) was a blacksmith who broke a leg and started drawing during his recovery. Unable to return to the forge Cox studied painting. He became very successful, exhibiting at the Royal Academy and writing books on art. Frank Leverall Day (American, 1902–76) was a migrant agricultural worker when a farm accident in 1959 broke both of his knees. Day, who began to make art in the hospital rehabilitation program, continued for the next sixteen years until his death. As a Konkow Maidu from California, Day created over two hundred paintings of Native American customs, ceremonies, and legends. Art became a way of preserving his culture for Day, who said, "If I do not do this, all things will be forgotten."

Traffic accidents, a leading cause of disability and death, can inflict severe injury whether people are drivers of cars like Ginny Ruffner or passengers like Howardena Pindell. In 1979 Pindell (American, b. 1943), an art professor, was riding to work at her university with two colleagues when a woman, who had been given pain medication, swerved across the meridian and hit their car. Pindell was trapped in the back seat, her hips misaligned and unconscious from a concussion. In response to the trauma, Pindell said, "My work changed drastically." She went from abstract painting to autobiographical imagery featuring a slave ship to acknowledge her African-American heritage. While the hip injury healed, Pindell still has neurological problems. Although she cannot see all the objects in her visual field, Pindell says she now can focus intensely on repetitive tasks and uses this ability to create intricate patterns in her paintings.

Ginny Ruffner (American, b. 1952) describes her near fatal auto accident in 1991 as "five weeks in a coma, five months in the hospital, and five years in a wheelchair." Trying to avoid another car that had cut across both lanes Ruffner lost control of her vehicle, crossed the median, and spun into ongoing traffic where she had a head-on collision with a first car and then was hit by a second one. In addition to great physical damage, Ruffner suffered a shearing brain injury and her doctors did not think she would live. Yet despite paralysis of her left side that included her drawing hand, double vision, spasms, and a seeming total loss of memory, Ruffner survived. When friends and family brought images of her work, Ruffner began to retrieve memories of her art and started to draw with her right hand. She said, "I knew I would make art again" that making art "was what brought me back." Ruffner now creates by making drawings and supervising assistants who build the finished sculpture. In addition to her previous medium of glass Ruffner has expanded her work to include metal work and book design.

Working With Quadriplegia

Auto accidents can also result in quadriplegia as they did for Ernie Pepion and John Callahan. Yet after being injured both men changed their lifestyles, went to college, and became artists. Ernie Pepion (Eewokso, American, 1943–2005), who worked from a motorized wheelchair with a hand and forearm brace to support his right hand, said, "I am an artist, Blackfeet Indian, and am

physically disabled.” Pepion used his paintings as political/psychological statements to counteract prejudice against quadriplegia and people of color. John Callahan (American, 1951–2010), who was one of America’s leading cartoonists, was also an author, filmmaker, and a role model for other disabled people. Callahan drew by sitting in a motorized wheelchair with a tablet on his lap using his left hand to brace his right.

Sports accidents are another cause of quadriplegia. Cindy Bernhardt (American, b. 1963) was a freshman in college when she was injured in a gymnastics accident and Trevor Wells (English, b. 1956) was an apprentice carpenter age twenty-one when he was injured playing rugby (Alexander, 2005). Completely unable to use their hands, they started making art in hospital rehabilitation programs and went on to have success as painters by holding brushes in their mouths.

When a blood clot lodged in his spine at age 47, Chuck Close (American, b. 1940) became quadriplegic. With very limited movement in his arms and legs, Close paints while sitting in a wheelchair with braces on his legs and a Velcro brush holder attached to his wrist. Two years before the illness Close, who had painted in black and white, began experimenting with color. After the incident his palette expanded, and he has become a colorist. A disciplined worker who paints steadily, Close states that “Every day when I roll out of my studio and look over my shoulder, I say ‘That’s what I did today.’”

Multiple Transforming Illnesses

While Frida Kahlo, Henry Ossawa Tanner, Nell Blaine, Itchiku Kubota, Chuck Close, Lawrence Alma-Tadema, and Odilon Redon all had more than transforming illness, few individuals have had their lives and art as affected by incidents of poor health as Henri Matisse (French, 1869–1954). He had five transforming illnesses. Matisse’s first transforming illness came at age twenty when intestinal problems he had since childhood flared into an acute attack. Forced to recuperate for months, and hoping that creativity might help his boredom, Matisse asked for art supplies. Upon receiving them from his mother he said, “The moment I had this box of colors in my hands, I had the feeling that my life was there.” When Matisse was in his late forties, bronchitis, his second transforming illness, forced him to move to the south of France. The beautiful colors of the Mediterranean brightened his palette and he became a great colorist.

Intestinal cancer at age seventy was Matisse’s third transforming illness. After an operation that went poorly, Matisse became an invalid for the rest of his life. Unwilling to stop working, he started drawing from his bed and then cut out pieces of colored paper while working in a wheelchair. Compositions made of colorful cut paper became a main form of expression for Matisse and include some of his best work. His fourth transforming illness was a gallbladder condition that came soon after the intestinal surgery. Refusing another operation, Matisse sublimated his pain by making book illustrations. The fifth transforming illness came in 1942 when Matisse’s poor health required a nurse. The young woman who was his nurse became a nun and asked him to design a church. Matisse was eighty-four when he finished the *Chapel of the Rosary* and said, “I consider it to be my masterpiece.” The courage and determination of Matisse and other artists to face hardship with creativity indicates the transforming illness is a widespread phenomenon and fundamental to the human condition.

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Trauma and Creative Transcendence

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The Therapeutic Action of Art

In 2004 Mihaly Csikszentmihalyi gave a TED talk revealing the genesis of his long-term interest in the subject of creativity. He attributed its beginning to his childhood in war torn Europe when he observed that while most of the adults around him were devastated by World War II, some managed to keep a positive attitude and somehow transcend the tragedy that they were exposed to. Eventually, he concluded that it was engagement in creative endeavors which provided people with meaning and thus helped them cope with the difficulties and tragedies of life.

Definitions of creativity abound; they are varied and complex. The focus in this chapter is limited to artistic creativity as a form of self-expression which holds the potential to promote healing in the wake of traumatic experience. In this context, creativity is not defined by the level of talent or skill of the creator, or the quality of the final product, or its value to society. The emphasis here is on creativity as a potential that exists in all of us, a universal potential which can be manifested when facing a challenging situation and striving to master it. In this context, creativity can be an attitude, an idea, an act, or a product.

The term *trauma*, like the word creativity, is defined broadly here. It is conceptualized as an experience or event falling on a continuum ranging from the inevitable losses that are part of the human condition, to the other extreme – exposure to exceptionally violent and catastrophic events outside of common human experience. Trauma is viewed from a contemporary psychoanalytic perspective and is defined by the experience of the survivor, whether consciously registered or not. Regardless of its specific nature, trauma involves a highly stressful situation that leaves the person emotionally, cognitively, and physically overwhelmed and feeling helpless and vulnerable.

The central thesis of this entry is that creative action is one of the most effective ways of coping with trauma and its aftereffects. Art can provide opportunities to repair what has been shattered by events that have overwhelmed individuals and rendered them helpless. It is in art, through its various metaphors and symbolic disguises, that sorrow is given shape and meaning. By expressing the pain, the artist externalizes it, fashions a container for it, and invites others to become witnesses to his/her suffering. Trauma-art facilitates mourning, it restores continuity and connection, and helps to master the internal chaos that follows in the aftermath of tragedy.

What is it about artistic self-expression which facilitates the working through of traumatic experience? What is the therapeutic action of art, in all its forms, whether writing, poetry, painting, drawing, music, dance, or any other art form? The creative transformations of trauma have been explored in psychology and psychoanalysis for many years by scholars from various theoretical perspectives. The answer to what is the therapeutic or beneficial function of art largely depends on one's theoretical orientation.

For instance, when Sigmund Freud wrote about art and the artist (1908/1959), he approached the subject from an instinct based drive theory model. Within that framework, he developed the concept of *sublimation*, a type of defense mechanism which involves the transformation of unacceptable impulses into socially acceptable actions. Ernst Kris (1952), using the same energy paradigm, extended and elaborated the concept of sublimation. He considered creativity to be one of the organizational functions of the ego and maintained that although the source of inspiration was regressive, the artist has a unique capacity for controlled regression to primary process. For this special ability, Kris coined the phrase "*regression in the service of the ego*." It is noteworthy, that these early formulations of creativity were framed in pathologizing terms like "regression" or as defenses against socially unacceptable impulses. Some of Freud's contemporaries, however, among them Carl Jung and Otto Rank, while still committed to the notion of primary process and the workings of the unconscious, moved away from the conception of art as a mechanism of defense, focusing instead on its potential for self-actualization.

Of those who early on recognized the healing potential of art, Jung's work on creativity stands out above all others, perhaps because it derives from his personal experience with internal demons, which he courageously shared with the world. While others were writing about healing through creative action from a theoretical position, Jung was a living example of it. Whereas some may find many of his metaphysical ideas somewhat archaic and experience-distant, his descriptions of his journey into his own psyche is vibrant and enlightening. For much of his life, Jung kept detailed daily journals filled with self-observations, random thoughts, dreams, visions and spiritual experiences.

Eventually in midlife he transferred the contents of these journals into an ornate volume bound in red leather known as *the Red Book* (Jung, 2009). This book provides an intimate look at the creative process born of trauma resulting in an artistic product with the potential to heal its creator. Jung's early history had been marked by traumatic disruptions of the tie with his mother, and according to Winnicott (1964), he suffered from childhood schizophrenia. In adult life, Jung experienced several breakdowns, one of which he documented in *the Red Book*. Through words and visual images, the book vividly describes and graphically illustrates, the intrusive images that he experienced, which in his words: "burst forth from the unconscious and flooded me like an enigmatic stream and threatened to break me" (Epstein, 2009).

Jung believed that what kept him from a state of madness was his self-analysis. He set out on an extensive and intense spiritual expedition into his inner life and the depths of his soul. Using his powerful intellect, his fertile imagination, and his considerable artistic talents, he created a world in which the disparate aspects of his self could be encountered and worked-through. For this endeavor, he developed a technique which he called "active imagination." This technique, which was a kind of meditation or visualization or hypnotic state, was conceptualized as a voluntary confrontation with the unconscious. After inducing an altered state, he would focus on what surfaced, concentrating on a single image or event and imagining himself into it. The images and dreams which emerged during these active imagination sessions, were then carefully recorded in writing or drawn or painted into his journals and a narrative was created around them. The insights which emerged as Jung practiced these techniques on himself were then generalized to others and became the template for his understanding of creativity and the creative process.

Jung's ideas about the creative process are compatible with contemporary psychoanalytic thinking which identifies creativity as a prime example of the human striving for growth. Although the notion of sublimation continues to be found in current literature, the predominant view emphasizes the transformational and restorative capacity of the creative experience. The shift from a position of compensation for what is lacking, to one of transcendence, has opened a window into the creative process as it attempts to deal with the traumatized and vulnerable self.

Theoreticians interested in the relationship between trauma and creativity have speculated about the nature of the healing process and how creative action plays a role in the transformation of despair and psychic pain. The sense of helplessness which traumatic events evoke, seems to cry out for actions that restore a sense of power to the victim. When the artist/victim finds a way to express the pain through words or actions that can be shared with others, he/she achieves some sense of mastery and connection. Rose (1987), who has written extensively on the subject of art and trauma, proposed that "both creative and clinical processes follow the fundamental psychic principle of attempting to master passively experienced trauma by active repetition" (p. 44). According to Rose, creative work externalizes inner processes and connects the person more intimately to the outside world. What begins as the task of mastering one's personal past for the creative artist becomes a process of externalizing and transcending it.

Rose's observation that creative and clinical processes share a common psychic principle, helps us to understand more specifically how these processes facilitate healing. Similarly, one can better understand the therapeutic relationship between art and trauma when one notes that they have another significant point of connection. The thesis of this entry is that the dissociative process is another link between traumatic experience and its artistic expression. It has been known for many years that dissociation is correlated with a history of trauma and is a common coping strategy of trauma survivors. However, the notion that dissociation is a significant aspect of the creative process is a relatively new idea that has not received adequate recognition. The following section will discuss the phenomenon of dissociation and its relationship to both trauma and the creative process.

Dissociation in Art and Trauma

Based on extensive personal and professional experience with both trauma and the arts, the author offers a new theory of the creative process and its potential for healing. The process of creation is seen as a purposeful (although not always conscious) symbolic reenactment of traumatic experiences that facilitates the working through of overpowering affects. This view of the creative process is a twofold one which involves both dissociation and witnessing as its key elements. Dissociation will be discussed in this section, witnessing in the next.

Dissociation is a general mental state which is different from one's ordinary mode of experiencing. It consists of an altered state of consciousness; a temporary change in one's mental state. The concept of dissociation has been prominent in psychology and in psychoanalysis since its first appearance in the work of Pierre Janet in the early 1900s. Since that time, it has generally been viewed in the context of mental illness (See Schizotypy).

Jung, whose model of personality was a dissociative one, was one of the early voices who referred to dissociation in more neutral terms. He viewed dissociation as a part of the normal operations of the psyche, although he acknowledged that in extreme cases it could have pathological manifestations. The technique of active imagination that he developed was a version of the dissociated state that he enlisted in his clinical work.

Historically the relationship between creativity and dissociation has received little attention in psychoanalytic circles, in contrast to the concept of *regression* which has been viewed as integral to the creative process since its introduction into the literature by Kris (1952). Only a handful of theoreticians have recognized the role of dissociation in creativity. One of the early references can be found in Weissman (1968) who used Kris' concept of regression as a springboard for his own ideas about the creative process and posited a dissociative or desynthesizing function, along with an integrative function of the ego. While he acknowledged the significant role of dissociation in creativity, his interpretation was framed in the context of drive theory and ego psychology, in contrast to the one offered here, which is grounded in the contemporary relational paradigm.

Among relationalists the prevalent view of dissociation continues to be a pathological one, but in recent years there has been some recognition of the fact that certain common and universal events like daydreaming and meditation and other altered states of consciousness are also examples of nonpathological dissociation, a process which can actually be restorative (Richman, 2014). Bromberg (1998) referred to “*healthy dissociation*” as an adaptive function of the human mind, which allows individual self-states to function optimally “when full immersion in a single reality, a single strong affect and a suspension of one’s self-reflective capacity is exactly what is called for or wished for” (p. 273).

The role of dissociation in the creative process is generally unrecognized in the current literature on creativity, with the exception of Csikszentmihalyi’s extensive writings on the concept of flow. Without specifically using the term *dissociation*, Csikszentmihalyi (1990, 2004) introduced the term *flow*, which perfectly describes an altered state of consciousness, or dissociation. He conceptualizes it as a state of consciousness which is automatic, effortless, yet highly focused. His studies of creative individuals from different disciplines indicate that what they have in common is the capacity to become deeply immersed and involved to the point where they can enter an ecstatic state in which their sense of self seems to disappear. Along with it usually comes a lack of awareness of bodily needs, a distorted sense of time, and a transcendence of normal awareness. When he writes about flow, Csikszentmihalyi does so in the context of positive psychology and his focus is on the inspirational aspects of dissociation (See Flow).

For those who are familiar with the hypnotic state, it is noteworthy that it has many common features with what Csikszentmihalyi calls “flow.” Hypnosis is a type of dissociation characterized by heightened attentiveness, receptivity, intense focal concentration, and diminished peripheral attention. In trance, one is able to temporarily put aside evaluative judgment and rational concerns and allow emotionality and imagination to hold sway. There is a greater openness to internal images and fantasies. Affect is intensified and more accessible, so that when it is used for trauma work, it has the potential to evoke the intense affect associated with the original traumatic event. Hence the power of artistic self-expression in working through and mastering traumatic events (Richman, 2014).

In summary, the dissociative state is here understood as an altered state of consciousness that is essentially neutral and paradoxical in nature. On the one hand, it can function as a defense mechanism, which under traumatic circumstances is subject to involuntary states of cognitive and affective alterations of consciousness; on the other hand, it can be a state of intense engagement which can be enlisted temporarily in the service of the creative process and has the potential to heal the creator, and under certain circumstances, to mend the reader or viewer, as well. Thus, the same dissociative process that is responsible for fragmentation of the self when the individual is beset by trauma, is also responsible for its transcendence at moments of inspiration when the artist is deeply immersed in creative work.

Bearing Witness, Being Witnessed, and Self Witnessing

Equally integral to the process of creation, particularly as it is enlisted for trauma work, is the concept of witnessing. Jorge Bose (2005), a contemporary psychoanalytic thinker, writing about the healing function of art brings together the two elements of dissociation and witnessing.

The function of the work of art, in a reciprocal process between the art object and its maker, in the making and in the performing of it, can then be seen as being able to reassert the ability to find meaning and symbolic form and therewith again to communicate to an other, to have a witness and to also communicate with oneself and with dissociated aspects of self-experience (p. 69).

Bose added a critical component which accounts for the healing potential of art. It is the author’s contention that communicating with another, as well as oneself, and having witnesses for one’s creation, is essential for repair and mending.

The witnessing function happens on a number of levels. First, the artist becomes witness to his/her own traumatic experience. By externalizing what is experienced internally as overwhelming and fragmenting, and by fashioning it into a creative product, the artist brings the traumatic experience into the light of day for a new viewing. This enables reflection and integration of something initially terrifying with no boundaries or definition, to be defined and integrated into a coherent meaningful narrative. Second, by sharing his/her art with others, (readers, audiences, listeners, spectators), the artist creates witnesses for the pain and as a result no longer suffers in isolation. Trauma is an alienating experience which often ruptures connections and interferes with one’s sense of continuity over time. The marker of life “before” and “after” tragic events, is a common designation by trauma victims. Having witnesses can restore lost connections and repair ruptures. Finally, the artist bears witness to disturbing events and memorializes them, as he/she writes about them, or paints them, or composes music to remember tragedies that have transpired.

An example of the integration of the three crucial aspects of witnessing can be seen in the art of Holocaust survivor, Marian Kolodziej, a Polish Catholic who at the age of 17, was imprisoned in Auschwitz in the first transport, after he was caught working for the Polish resistance. Somehow Marian managed to survive the horrors of concentration camp life for the duration of the Second World War, after which he returned to Poland, went to art school, and eventually began a brilliant career as a set and costume designer in theater and film.

Like so many other survivors, he did not speak of his traumatic experiences in the concentration camp until many years later. At the age of 72, after he suffered a severe stroke which resulted in the paralysis of his hands, and limbs, he turned to drawing as a form of rehabilitation and began to address his past trauma through his art. His poignant drawings of scenes which he remembered from

his years in Auschwitz became a way of finally facing old demons and bringing them to the light of day after so many years of remaining hidden. His encounter with death the second time around was the stimulus to ultimately come to terms with the past and to give testimony through his art (Schmidt et al., 2010).

For Kolodziej, as for other survivors, the function of witnessing was essential. It took place on several levels, including bearing witness to the tragedy, being witnessed by those who came to see the exhibition of his work, and bearing witness to himself by facing what he himself had been through – Kolodziej's art enabled all three. He frequently made use of the self-portrait, bringing images of his past and present selves into the same frame and juxtaposing them with one another. Through this technique of the double self-portrait he was able to literally and figuratively bear witness to himself – the current self witnessing the traumatized self and acknowledging its suffering and its triumphs. This appears to be an ingenious and creative way of artistically portraying the psychological phenomenon of *doubling* so familiar to survivors of catastrophic trauma. Most survivors exist in two separate worlds, the world of the trauma experience, and in present time. In his creative way, Marian manages to find a way to symbolically integrate them. In this artistic version of *doubling* there is an opportunity to regain a sense of continuity that had been ruptured by trauma.

This internal "witnessing-other" can be viewed as a kind of Muse (Richman, 2014) that is often conjured up in the process of making art. For the trauma survivor, whose experience has been chaotic and fragmenting, the witness can serve a holding function as well as a validating and integrating one. The imagined witness is conceptualized as a dissociated self-state that serves the crucial function of mirroring, affirming, and validating. When traumatic experience is transformed into a work of art, a poem, a collage, or a photograph, the survivor is able to bear witness to his/her own experience; the final product is an external presence and a memorial to what has been lost. Marian's drawings illustrate how artistic expression can be enlisted in the service of working through a traumatic loss, mourning this loss, and preserving memory. As he recalls scenes from Auschwitz, unformulated experiences of pain and loss are given form.

The roles of dissociation and witnessing in the creative process are complementary and essential. They are the building blocks of the new relational theory of creativity that is offered here. What exists inside as unformulated chaos can be formulated, that is, given shape and meaning and witnessed by self and other. Through the creative process, painful disorganizing and overwhelming affects are shaped into images or ideas that have a substance and a reality and can be validated by others. This process counteracts the tendency toward defensive dissociation, the common legacy of trauma. The creative product exists as evidence of one's experience at a specific moment in time and, as such, it endures the vicissitudes of shifting self-states thereby facilitating their integration into a coherent and continuous sense of self. Ultimately, it can contribute to a sense of mastery and empower the trauma survivor.

The creative process is often regarded as a solitary activity, but in fact one can make the case that the presence of the other is always implied since most artistic products are meant for an audience – a viewer, a listener or a reader. Even when there is no actual audience present, an image of an external other may exist in the form of a projected other who will react to the creation and to the individual doing the creating. Kris (1952) wrote: "Wherever artistic creation takes place, the idea of a public exists, though the artist may attribute this role only to one real or imaginary person" (p. 60). The response of others, according to Kris, is essential to confirm the artist's belief in his work and to restore a balance that the creative process may have disturbed.

The viewer or reader or listener who witnesses the creative product, potentially benefits as well. Anna Ornstein (2006), a psychoanalyst and survivor of Auschwitz, wrote about artistic transformation of individual suffering and the transformation of traumatic memories into works of art. She maintained that art can serve a vitalizing selfobject function, a narcissistic experience in which the art object functions in the service of the self fostering the experience of continuity, coherence and well-being for the survivor as well as for those who are consumers of the art work.

Ornstein postulated a complex relationship between the work of art and its audience; a shared experiential space between the subjective reality of the viewer/reader/listener and the artist. Within the self psychology theoretical perspective, she understood artistic creativity as an attempt to ward off or repair fragmentation and to facilitate the re-integration of thought, emotion, and perceptions ruptured by trauma.

Orfanos (2014) wrote about the world renowned composer and activist Mikis Theodorakis, whose melodies and compositions evoke powerful emotions in his audiences and listeners: "Theodorakis creates an intimate dialogue between himself and the listener. Composer and audience collaborate to create a memorializing dialogue by way of relational mourning. This dialogue affirms the powerful feelings of loss and death." (p. 276).

Theodorakis, a survivor of torture during World War II and the *junta* years in Greece (1967–74), knew grief from the inside out and helped his people to collectively mourn and memorialize the deep damage done to their country. Orfanos maintained that Theodorakis' compositions integrate powerful words and sorrowful sounds which evoke passion, longing, and loss. The aesthetic structure allows the listener to enter a safe holding environment where these powerful emotions can be experienced and shared.

Enlisting the Creative Process in Psychotherapy

Jung encouraged his patients to use the technique of active imagination, which had been so curative for him, so that they could uncover their own fantasies and then draw and paint the images that emerged in this altered state of consciousness. Some contemporary practitioners who share Jung's view of personality as dissociative in nature, developed similar techniques in their analytic practice. For instance, Robert Bosnak (2003), a Jungian analyst, uses a method of dreamwork to access psychic states that are normally out of consciousness. He induced a hypnagogic state and guides the person to re-enter his/her dream. His goal in using this imaginal work is to let various aspects of self become aware of one another. Similarly, Bromberg (1998) a relational psychoanalyst,

reported that he occasionally used *embodied imagination*, a creative form of working with memories and dreams based on Jung's principles, when he encounters self-states that have been isolated self-protectively through dissociation. He views this aspect of dissociation as 'normal dissociation' – an aspect of the natural hypnoid capacity of the mind that works in the service of creative adaptation (See Dreams and Creativity).

In clinical practice it is sometimes helpful to work with artistic products that patients spontaneously bring into their sessions, such as a poem, a story, or a painting. Working with symbolic material and images, much like dream work, can be gratifying and enlightening; it engages the creator in a way that can often bypass the censor within. Rotenberg's (1988) formulation suggests how this process takes place: "Unarticulated feelings and ideas are externalized and in the process of their articulation (whether in words, or visually in form and color, or in music) the creative work itself is supposed to validate the artist's not fully conscious intentions" (p. 387).

For creative patients who have lived in the shadow of trauma, artistic self-expression is often particularly compelling. The following vignette illustrates therapeutic work with such a patient. "Samantha" was referred by a physician colleague who worked with her child, a 7-year-old with special needs, whose functioning was severely compromised by a condition similar to autism. The child was multiply disabled, had visual issues, was hearing impaired, and had life threatening allergies to countless foods. One of the most dramatic aspects of her condition was her inability to speak. The mysterious disorder did not even have a name, nor could it be explained by a specific diagnosis.

The trauma of living with a severely handicapped child began late in the pregnancy when Samantha was told that the little girl that she was carrying might not survive beyond the first months of life. Samantha's life consisted of countless visits to various medical specialists, many of whom made dire pronouncements about the future of her baby. She had to give up any plans to be a working mother with a gratifying career, because this child required her full commitment. She could not, or would not, leave her in the care of others. The trauma was ongoing and cumulative; she felt trapped and hopeless. With the birth of this child, the couples' lives were changed forever. Fortunately, they had a good solid, affirming relationship, and Samantha's husband was able to financially support the family and provide the numerous services necessitated by the child's medical condition.

Long before the trauma of parenting a child who was so severely compromised, Samantha had experienced depression and anxiety. Born to a highly critical mother who had strong convictions about the ways that children are supposed to look, behave, and think, and a father who was emotionally distant and abusive, Samantha had learned early on to hide her own values, her thoughts, and even her talents. She recounted how as a child she had hidden her art work under her bed so that she could avoid the criticism which she anticipated.

Samantha's intense anxiety, particularly as it related to the transference, was a recurrent theme in her treatment. Despite her strong attachment to the therapist, and her valuing of the psychotherapy process, she consistently experienced a sense of apprehension in anticipation of her sessions. Sometimes her anxiety took the form of losing her voice. As she spoke about upsetting experiences, she suddenly felt her throat closing up and had difficulty speaking. Anticipating a critical reaction, Samantha had learned early in her life, to keep her thoughts and feelings to herself. Besides the fear of external judgments, she was terrified of entering a dark place from which there would be no return. Caught between the need to express herself, and the wish to escape into silence, she struggled in therapy to face her demons and to find her voice.

While speaking was conflicted, writing was not subject to such inhibition. Samantha loved books, and writing was a form of self-expression that came naturally. Within the first year of therapy, she announced that she was joining a writing group. Apparently, she not only loved fiction writing, but had a talent for it. She found the writing group immensely gratifying; it not only enhanced her self-esteem, but it also facilitated a sense of community with like-minded individuals. It helped her bridge the chasm of isolation that surrounded her. Her fellow-students were captivated by her short stories, and the teacher encouraged her to publish some of them. Eventually a couple of her pieces were accepted for publication.

Sometimes, Samantha brought her stories into sessions by mentioning what she was working on. Much the way that we might explore her dreams, we approached her tales as an opportunity to gain deeper insight into her internal experience. What did these metaphors tell us that we did not already know? How did they add to our understanding of her experience? Generally, Samantha would describe her tales, but one day she actually brought in a completed short story which she handed to the therapist with a mixture of trepidation and anticipation.

The story featured a mannequin named Zoe who spend her days and nights in a department store window watching the world go by until one day, when apparently she had outlived her usefulness, she found herself discarded in a garbage dumpster. The story is told from Zoe's perspective as a thinking, feeling, sensing being. She has strong emotions; she feels panic, despair, longing, but to the world, she is a wooden human-like mannequin in a window display. Zoe is witness to the changing seasons and to life going on around her, lovers kissing in front of the display window at night when the store is closed, children watching with wonder, and shoppers imagining themselves in the attractive seasonal outfits on display. Zoe is rescued from the dumpster by the man who is in charge of dressing the mannequins, and it is he who gives her the name Zoe. Samantha's husband has been the rescuer in her life who recognized her specialness many years ago when they were college students. But even this man cannot know the depth of her longings for life and her deep sense of isolation.

The name Zoe (the Greek word for life) so well captures the irony characteristic of many of Samantha's stories. They are filled with parody and paradox; they depict unsettling events and have a powerful and haunting presence. This beautifully written piece captures the experiences that she talked about in therapy – her description of herself as a "people pleaser" in juxtaposition with her inner sense of herself as lifeless and broken; her experience of her mother as an insecure person who is preoccupied with the reactions of others and with superficial concerns like physical appearance and good manners. The therapist wonders if this story, which

she wants to share, is a parody of her mother's expectations – namely, the wish to have a daughter with a perfect body and a frozen smile who shows no uncomfortable emotions and makes no demands, a mannequin-like figure without human flaws. At the same time, the story seems to have multiple meanings, much like a dream, suggesting that Zoe also represents her own child – a pretty girl without speech, who is dependent on the caretaking of others, yet unable to communicate her basic needs, her thoughts, or her feelings.

How does writing her stories help Samantha mend? Through metaphors and images, she faces the traumatic experience from a safe distance. By sharing them with her writing group she allows others into her closely guarded inner world on her own terms. By bringing her poignant stories into her therapy sessions, she invites her therapist to witness her own inner struggle, her longings, and her suffering. "Helplessness and isolation are the core experiences of psychological trauma. Empowerment and reconnection are the core experiences of recovery." (Herman, 1992, p. 197).

Creative self-expression provides an opportunity to mourn, to memorialize, to find meaning, and to regain some sense of continuity and connection. Through emotional engagement and creative action, passively experienced trauma can be mastered and ultimately mended. From the tragedy of trauma, through her imaginative stories, Samantha constructed something of value that could be communicated, recognized, and witnessed and has the potential to restore connections ruptured by trauma. For Samantha, as for so many trauma survivors, the creative act is both a source, and a sign of vitality and empowerment.

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Further Reading

Richman, S., 2014. *Mended by the Muse: Creative Transformations of Trauma*. Routledge, New York/London (This book contains many additional references and details, as well as elaborations of some of the ideas that are presented here).

Relevant Website

A documentary film, *The Labyrinth: The Testimony of Marian Kolodziej* is available at www.thelabyrinthdocumentary.com.

Unconscious

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There is a long-standing belief in the unconscious wellspring of creativity. Invoked more frequently in connection with creativity than with almost any other human action or experience, the unconscious is considered responsible for mysterious bolts from the blue, flashes of insight, waking from sleep with ideas already formed, and energy-releasing altered states of consciousness. Also, creative writings and works of art seem perfused with unconscious content such as Oedipus complexes, anima and animus, or sexual and aggressive symbolism. So ingrained is the idea that creativity arises from unconscious sources that investigators who present evidence for conscious factors do so at their peril; they run the risk of being rejected out of hand by both professionals and laity.

The belief in the unconscious roots of creativity is tenacious and misleading. Because creativity is unconscious, the adherents often also say, it cannot be explained or adequately understood. Moreover, this belief is closely allied to allegations about a connection between creativity and madness. Nietzsche's concept of the creative artist's Dionysian frenzy, for example, anticipates modern constructions of unconscious influences and emphasizes an extreme irrationality of the creative mind. These ideas, in fact, have a long and almost hallowed history. They go back to the philosopher Plato, who laid their groundwork in the following remarks to the poet Ion:

For the poet is a light and winged and holy thing, and there is no invention in him until he has been inspired and is out of his senses and the mind is no longer in him; when he has not attained to this state, he is powerless and is unable to utter his oracles. Many are the noble words in which poets speak concerning the actions of men; but like yourself [Ion] when speaking about Homer, they do not speak of them by any rules of art: they are simply inspired to utter that to which the Muse impels them, and that only; and when inspired, one of them will make dithyrambs, another hymns of praise, another choral strains, another epic or iambic verses-and he who is good at one is not good at any other kind of verse: for not by art does the poet sing, but by power divine. Had he learned by rules of art, he would have known how to speak not of one theme only, but of all; and therefore God takes away the minds of poets, and uses them as his ministers, as he also uses diviners and holy prophets, in order that we who hear them may know them to be speaking not of themselves who utter these priceless words in a state of unconsciousness, but that God himself is the speaker, and that through them is conversing with us. (Plato, 1924a)

This does not mean that in this passage Plato formulated a concept of an unconscious or that he considered the roots of creativity to lie in some particular aspect of the human mind. On the contrary, he clearly considered creativity to be supernatural or divine in origin and, in another place, stated explicitly that the creative artist's performance was the result of "divine madness." (Plato, 1924b) When performing creatively, the artist's own senses were not directly responsible for the product, and consequently the creative process was a matter of being out of one's mind and bereft of one's senses. Such emphasis on the seemingly possessed aspect of creative activity has been a basis for a long tradition citing both madness and supra-human or external sources for creativity. It has, on the one hand, continued and fostered the classical idea of inspiration by the muse, and on the other, it has today culminated in a psychological emphasis on the unconscious aspect of the mind: rather than ideas being inspired by a source outside the creator himself, they have been located within the creator as another aspect of his mind. Although the idea of creativity arising from the unconscious is not the same as Plato's madness notion, it raises many problems. The modern concept of the unconscious is primarily associated with psychoanalysis and Sigmund Freud. Although Freud actually did not originate the concept-others such as [Eduard von Hartmann \(1869\)](#) proposed it earlier-he was the first to develop a full and systematic theoretical account. Other theorists, notably [Carl Jung \(1966\)](#), also attempted a systematic description of unconscious functioning called the "Collective Unconscious", denying certain aspects of Freud's concept and adding cultural, historical, and other features. Although Jung's concept of the collective unconscious has had a prominent place in some modern theories of creativity, it would not be contributory here to go into a recounting and assessment of the differences between Freud's and Jung's theories of unconscious functioning. As the major

thrust of the matter is similar for both, I shall focus on the Freudian unconscious and only touch on similarities and differences from the Jungian.

Freud and other psychoanalysts fostered the idea that the unconscious and its operant primary process thinking (non-logical nor reality-oriented) plays a significant role in creativity. Turning to great works of art in order to corroborate findings about psychological processes derived from work with patients, psychoanalysts have long been interested in apparent manifestations of the unconscious and the primary process in works of literature and visual art. In his initial presentation of his cornerstone concept of the Oedipus complex, Freud turned for illustration and support to Shakespeare's great play *Hamlet*. Citing Hamlet's inability to act against his uncle-stepfather, together with the intense relationship between Hamlet and his mother, Gertrude, Freud proposed that unconscious incestuous feelings toward Gertrude and murderous feelings toward his real father could explain Hamlet's doubt and torment. After this and other artistic analyses by Freud, numerous other psychoanalysts have attempted to describe myriad instances of unconscious phenomena in works of art. Because of the seeming universality of these instances, creative artists were alleged to be particularly sensitive to their own unconscious processes, and these processes were considered to play a critical role in artistic creation. Artists' own testimonies have also strengthened these considerations. Repeatedly, artists of all types report that they cannot trace the steps in their achievement of outstanding ideas and that such ideas seem to intrude into their awareness without warning or preparation. In many cases, important ideas are said to arise when the artist is not directly working on a creative task but rather while he is relaxing or occupied with something else. In effect, therefore, the Platonic idea of possession by an external factor has been changed to a factor that is external to awareness.

Here, however, there needs to be a caution and a clarification regarding a distinction between the unconscious and the not-conscious. If something is simply described as outside of awareness or not conscious, it is only a negative factor. Saying "no," negating, or canceling out produces broad categories, and describing someone or something as "not tall" or "not hot" merely eliminates a characteristic rather than sharpening or clarifying the description. Although we often use negations as though they were opposites, "not tall" is not synonymous with short, and "not hot" is not equivalent to cold. The negatives of tall and hot include a very large range of height and temperature. Failure to recognize these differences has caused problems with respect to the idea and term "unconscious". It is used both to mean an opposite of consciousness and (together with the other old and misused term, "subconscious") as a negative form roughly equivalent to not-conscious or nonconscious. With respect to creativity and mental illness, lack of clarity about the distinction has caused confusion and misconceptions.

The Unconscious in Creativity

The Freudian definition of the unconscious does not only signify the negative of consciousness, it has specific contents and characteristics. Intrinsic to Freud's psychodynamic point of view is a definitely formulated and therefore positively defined unconscious, an unconscious that is *opposite* to the conscious. Freud's unconscious consists of elements derived from the individual's past which are kept out of awareness for a reason. These elements, designated as drives, wishes, memories, and affects, remain unconscious to the individual himself because they are unacceptable, either personally or socially, and therefore cannot be tolerated in consciousness. They are kept unconscious by the defense mechanism called "repression", an active psychological process or barrier.

Also, elements in the unconscious have a diffuse and controlling effect by virtue of being kept out of awareness. These elements exert a consistent and potentially broad effect on conscious thought and behavior precisely because they actively remain unconscious. Once an element becomes conscious—once its form and substance are known—then it can be changed and modified by intentional control. When unacceptable personal memories, wishes, and affects are kept out of awareness or repressed, they still have force and influence, but they exert an involuntary effect. And the more strongly they are prevented from coming to awareness, the more broad and diffuse is their effect. Strongly repressed unconscious drives, for instance, tend to influence all conscious thought and behavior. Although the matter is somewhat different with respect to the Jungian collective unconscious, the contents and themes of this type of unconscious are derived from the past, too, and they also exert a controlling effect on individual consciousness.

Now, if this type of unconscious were fully responsible for creativity, as many theorists contend, what would that really mean? What would that signify about the nature of creative processes? For one thing, with this type of unconscious and the controlling force of past events as entirely responsible for creative activity, we would have to restrict the definition of creativity severely. True newness, consisting of a complete break with the past, would not be a characteristic, or even a feature, of the creative process or of creations. Creations could not be truly new because they would be the direct product of past and preexisting unconscious factors. A meaningful definition of creativity should include the possibility of human beings producing truly new ideas, theories, artistic styles and forms, or inventions. Consequently, the contention does not work.

A second more telling result of this theory would be that the unacceptable and, in fact, the ordinary and banal contents of the unconscious would be the basis for great works of art and other important human achievements. Although this proposition is not as offensive right off the bat to myself as it is to some, on serious consideration it produces thorny problems. Works of art are decidedly not offensive or unacceptable or banal, and therefore some type of transformation or change would have to occur on the way from the unconscious to the final product. Rather than the unconscious, the particular transforming factor—whatever it is—would become the real cause of creativity. The biggest problem with accepting this idea of unconscious causes of creativity is the tied-in feature of a broad controlling effect on conscious thought and behavior. For although this control could plausibly account for representation of unconscious factors in the content of an artwork, it could not account for artistic form. A primary function of the Freudian

controlling mechanisms is to conceal unconscious content: they alter and distort unconscious material so that it cannot be recognized in consciousness. But artistic form—the shape, patterns, styles, and compositional features of artworks—has an opposite function: it uncovers and reveals deep meanings and psychological processes. It shows the organization of the feelings and actions of human beings as well as of the sounds and sights of nature. Independence from unconscious control of the processes responsible for form is necessary in order to produce revelation rather than concealment and the lucidity of art rather than obscurity. Also, a broadly controlling unconscious force could not produce intrinsically important unities in art, but, because the unconscious is essentially disunified, it would result in disunity or monotony.

Although Jung's collective unconscious is not necessarily a repository of unacceptable affects, drives, and memories, there are similar problems with that formulation. Characteristic themes of the collective unconscious such as the wise old man, the great uroboric or unisexual mother, and the birth of the hero, must also be transformed or changed to have a creative effect. According to Jung, these themes have been transmitted throughout history and are embedded in the past of particular racial and cultural groups or of the human race as a whole. He says the artist uses unconscious "autonomous complexes" to transform these themes into art. (Jung, 1996) This formulation, unfortunately, is redundant and circular and will not do. According to this, autonomous unconscious factors produce both *autonomous* form and content in art.

Despite all these difficulties, there is something to be said for the theories. Aspects of these positively defined types of unconscious functioning, Freudian and Jungian, must play some role in artistic creative production. Ordinary conscious thinking is too stepwise, too free of affect and emotion, and too focused on the natural world and on things as they are to provide the kind of remote and unusual connections and penetrating affective experiences characteristic of art. Emotion-laden operations of the Freudian unconscious which link childhood and adult thoughts and experiences together, infuse feeling, and produce constant shifts in thinking without regard to specific goals play important roles in various phases of the creative process. Also, there is little doubt that artists' unconscious conflicts (and perhaps also the contents of the collective unconscious) determine preoccupations with recurrent themes—although these do not comprise creative transformations. All types of artists return over and over again to themes having the basic structure of some unconscious element, be it the Oedipus complex, bisexuality, castration, reunification with a mothering or fathering figure, or the themes of the collective unconscious. The Oedipus complex, for instance, was not only the concern of Sophocles and Shakespeare, but more recent writers such as Nathaniel Hawthorne, Herman Melville, Eugene O'Neill, Edgar Allan Poe, Samuel Butler, Fyodor Dostoyevsky, Arthur Miller, Tennessee Williams, Harold Pinter, Edward Albee, and Samuel Beckett show definite preoccupation with various aspects of this theme, as do other types of artists as well.

The Nonconscious and Conscious in Creativity

The other type of unconscious functioning is the one that is designated simply as nonconscious. Neural scientists such as Walter B. Cannon (1932) and Charles S. Sherrington (1906) have both argued extensively that creative ideas arise from the nonconscious portion of the mind. Also, Csikszentmihalyi (1996) has proposed that creativity results from what he calls "flow," a state of fully devoted attention and thinking that includes application of nonconscious processes. Unfortunately, the concept of the nonconscious is, as I said, a negative one and is therefore very broad. Proposing a nonconscious mind without any specific attributes like those described by Freud and Jung has only increased the mystery. Discovery of the specific homospatial, janusian and sep-con articulation processes in creativity as described in these volumes, however, does help to solve this problem directly. None of these processes appears directly in awareness, and none of them arises directly from either the Freudian or the Jungian unconscious. None follows the patterns of ordinary stepwise or productive thinking.

With either or all three of these processes, creators are only consciously aware of the products of their thinking. Only the resulting metaphor, characterization, plot idea, visual image, musical phrase, or theoretical formulation appears in consciousness, not the structural features of these processes such as searching for opposites (janusian), superimposing mental images (homospatial) or separating with connecting (sep-con articulation). Because the creators are not aware (and do not need to be aware) of the structure of their thinking and seldom if ever retrace particular thought sequences leading to creative ideas, the ideas seem to them to result from factors out of their control. Because creative persons have intentionally not distracted or hampered themselves in order to focus on, or become aware of, the detailed nature of their thinking, they have never described these processes in their own writings and testimonies about creativity. Only through extensive and painstaking cooperative interviewing and sequence reconstruction together with observation and experimentation have the processes been revealed to me.

The structural features of the janusian, homospatial and sep-con articulation processes account in part for the numerous reports—adding to and abetting a virtual mystique of unconscious creativity—of something coming from out of awareness. In the case of the janusian process, there is a leap of thought in which the multiple opposites or antitheses are brought together at once. Ideas, images, or propositions traditionally considered valid or real are juxtaposed with their polar opposite or opposites; the coming together of such widely disparate elements produces a feeling and experience of something coming out of nowhere. Because the polar opposite has not been seriously entertained previously to be true or meaningful—sometimes not even to exist at all—it is held at the periphery of consciousness. Bringing it together with an idea that is in the focus of attention produces a sense of sudden insight or a leap of thought.

In Albert Einstein's development of the general theory of relativity (Rothenberg, 2015) and described here in the chapter on janusian, homospatial and sep-con articulation), for example, he had considered all the characteristics of gravitation and motion

prior to formulating the key step. He had pondered moving objects, speed, acceleration, and especially the motion of magnets in an electrical field. Rest, the opposite of motion, was the limiting condition at the fringes of the matter until he brought rest and motion together in an image of a person falling from the roof of a house-at rest within his fall. And he described this idea as a thought that came to him while he was working on an essay-he was focused only on the new understanding he had achieved, not on how he had achieved it. Certainly aware that the idea seemed contradictory-in the report I cited elsewhere here- he carefully took up each apparently discordant detail-he was nevertheless moved by his thought. The experience of extreme disparity, the turning around of what was previously believed to be totally untrue or contradictory, is what accounts for the strong feelings of suddenness and strangeness and, in many cases, the sense of outside influence.

The scientist Edwin McMillan also spoke in a research interview (Rothenberg, 2015) of a sudden realization in his discovery of the principle of phase stability. He thought of a particle being out of phase and conceived that it shifted to the "opposite sense". This idea was the breakthrough that led to his recognition of constantly oscillating particles that were in a stable state. Going over the sequence in his thinking several times in order to be sure I had made no mistake in interpretation, I asked him whether he knew that he had conceived of an opposite direction and of simultaneously opposite energy levels. Acknowledging retrospectively that these were his conceptions at the time, he then went on to elaborate on the product of his thinking-the actual phase stability principle he had discovered. In response to further questions, he also made absolutely clear that he was fully conscious and rational at the moment he developed the idea but thought about the content rather than the way in which he had achieved it.

Similarly, with poetry, Pulitzer prize winner James Merrill, whose initial idea for a poem had been that horses are animals who "renounce their own kind in order to live our lives and did not, in a research interview, initially comment on the oppositional characteristics of this thought (Rothenberg, 1979). He had been reading a poem about men and horses written by another poet when he developed the formulation. When I then pointed out the simultaneous opposition in the structure, he completely agreed that it was there and, like McMillan, went on to elaborate on extensions of his conception. Animals, he said, were often more gentle than human beings, and humans often behaved in what were considered "bestial" ways. At the moment of developing his janusian idea about horses for a particular poem, he had not stopped to think about the oppositional structure of his thinking. Appropriately, he was only intrigued by the poetic notion itself.

Creative thinking is nonconscious in this respect primarily. In each case, creators are not generally aware of the specific structural features of the unusual modes of thought which they use in producing a creation. These types of thinking occur, however, when they are fully conscious and in possession of their senses. Neither dreaming nor in a special altered state of consciousness in which unconscious material becomes available, they are not engaged in "regression in the service of the ego." (Kris, 1952) According to that theoretical formulation, unconscious processes erupt into consciousness and, in an unexplained and mysterious way, are controlled by the ego for creative purposes. Instead, the creator characteristically tends to formulate simultaneous oppositions, superimpositions and connection/separations in the creative process without paying attention to how he does so.

The overemphasis on the unconscious, a virtual mystique and its related idea of possession, is therefore a mistake. But that is not the complete story. All conscious thought is in some way influenced by unconscious processes, and janusian, homospatial and sep-con articulation conscious types are not exceptions. For instance, there are often unconscious factors influencing a creative person's focus on a particular task, his or her choice of a particular set of opposites, or the elements superimposed in the homospatial conception or the life connections in his formulations. At times, these particulars may be derived from unconscious conflicts. Although the relationship of janusian, homospatial and sep-con articulation processes to unconscious material is primarily a separate and variable one, unconscious factors and content do appear in creative works, especially artistic ones. In such cases, aspects of the structure of these specific creative processes may be co-ordinate with unconscious dreaming factors and they therefore may to some extent facilitate the appearance of unconscious material in all types of art. I have described (Rothenberg, 1979) this factor as "the mirror image (reversal) of dreaming." The creative processes, because of their psychic structure, reverse aspects of dream thought and they thereby facilitate or unearth some unconscious factors and content. The janusian process involving opposites applies the defense mechanism of negation which suppresses and reflectingly focuses on unconscious content and produces the interchangeability of opposites in dreams; the homospatial process involving spatial superimpositions applies and reverses the dream mechanisms of condensation and compromise formation; and the sep-con articulation process applies and reverses the dream mechanism of displacement.

To come full circle, Plato's description of the matter was not really so far off the mark. Only his conclusions regarding madness and the tradition he fostered, which emphasize a source of creativity completely external to consciousness, are found wanting. The reason the creator is unaware of the specific factors accounting for his skill or art is that he appropriately does not think of the particular structural qualities of the thought processes he uses in producing his creations. They are part of that diffusely negative nonconscious aspect of his mental functioning, and to some degree, they are derived from the specific and positive unconscious defined first by Freud. The creator is, however, neither out of his mind nor bereft of his senses. He is a more sensitive and flexible thinker than the rest of us and is capable of using thought processes and blending modes of thought in unusual and exciting ways.

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Utah Conferences

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Utah Conferences

In the 1950s, the National Science Foundation (NSF) sponsored a conference series about the identification of creative talent in science organized by Calvin W. Taylor as the principal investigator and supported by the University of Utah. Three different conferences, titled, *Research Conference on the Identification of Creative Scientific Talent*, were held in Brighton, Utah. The first was organized in 1955 and followed on a biennial basis in 1957 and 1959. The idea for a creativity conference arose from discussions with Harry Kelly and Bowen Dees from the NSF, and the key figures in educational research, such as J. P. Guilford, Benjamin S. Bloom, and Donald W. Taylor, served as the conference organizing committee members. All the presentations and question–response sessions were recorded; and later, transcriptions were published by the University of Utah.

In his talk, Bowen Dees from NSF explained the reasons the conference was supported by the NSF. The NSF was “intensely and continually interested in the question of finding and nurturing those individuals who possess the potentiality for creative accomplishments in science.” As a relatively new institution, the NSF was offering research grants and fellowship programs for researchers in science. One of their motivations was to identify young scientists with high creative potential for their fellowship programs. The NSF also aimed to lead the transformation of administrative or environmental conditions in such a way that they became conducive to scientific outcome in research institutions. The conference encouraged researchers to produce research proposal(s) to expand efforts in identifying creative talent. In an initial document, the NSF documented its main concerns about research in creativity in science. Their primary questions were:

- *What distinguishes a highly original scientific investigator from an apparently equally intelligent scientific contemporary who simply develops and analyzes the ideas of others?*
- *How can the term creativity in science be defined meaningfully?*
- *Is it possible to develop measures of potential for creativity in science and if so, at what stage in an individual's development can such measures be applied?*
- *What additional research is needed in this field?*

It is remarkable that creativity received attention by the NSF and outstanding researchers in a relatively early period. Sir Francis Galton's *Hereditary Genius* (1869) was a pioneer study in creativity research history. However, before the 1950s creativity was primarily associated with intelligence and usually considered in the context of giftedness. The field “creativity research” emerged and was embraced by researchers after J. P. Guilford's seminal speech on creativity at the American Psychological Association convention in 1950. He highlighted that intelligence is not enough to explain certain behaviors or abilities, and the subjects of creativity and divergent thinking had been neglected by psychologists. Hence, he urged researchers and practitioners in psychology to exert more effort to develop appropriate assessment tools to measure creativity, understand the creative personality, and foster creative ability in schools. The Utah creativity conferences were the result of the momentum in creativity research gained after Guilford's 1950 presidential address.

Another factor making these conferences important is the outstanding researchers from the field of educational psychology including J. P. Guilford, Frank Barron, Morris Stein, and Benjamin Bloom. Below is a list of the some of the important speakers and the titles of their presentations.

1955 Conference

- Bowen C. Dees, *NSF Interests in the Problem of Identifying Creative Scientific Talent*. National Science Foundation, Washington, D.C.
- Robert C. Wilson, *The Program for Gifted Children in the Portland Oregon Public Schools*. Portland Public School and Department of Psychology, Reed College, Portland, OR.

- David R. Saunders, *Some Measures Related to Success and Placement in Basic Engineering Research and Development*. Educational Testing Service, Princeton, NJ.
- Lindsey R. Harmon, *Social and Technological Determiners of Creativity*. Office of Scientific Personnel, National Research Council, Washington, DC.
- Donald C. Pelz, *Relationship between Scientific Performance and Other Variables*. Survey Research Center, Institute for Social Research, University of Michigan, MI.
- Joe H. McPherson, *A Proposal for Establishing Ultimate Criteria for Measuring Creative Output*. Personnel Department, Dow Chemical Company, Midland, MI.
- J. P. Guilford, *The Relation of Intellectual Factors to Creative Thinking in Science*. Department of Psychology, University of Southern California, Los Angeles, CA.
- David C. McClelland, *The Calculated Risk: An Aspect of Scientific Performance*. Psychological Laboratory, Wesleyan University, Middletown, CT.
- Henry S. Dyer, *Some Problems in Identifying Creative Scientific Talent at Various Academic Levels*. Educational Testing Service, Princeton, NJ.
- Maury H. Chorness, *An Interim Report on Creativity Research*. Personnel Research Laboratory, Air Force Personnel and Training Research Center, San Antonio, TX.
- Frank Barron, *The Disposition Toward Creativity*. Institute of Personality Assessment and Research, University of California, Berkeley, CA.
- Morris I. Stein, *A Transactional Approach to Creativity*. Department of Psychology, University of Chicago, Chicago, IL.
- Benjamin S. Bloom, *Report on Creativity Research at the University of Chicago*. Board of Examination, University of Chicago, Chicago, IL.
- Brewster Ghiselin, *The Creative Process and Its Relation to the Identification of Creative Talent*. Department of English, University of Utah, Salt Lake City, UT.
- Robert H. Knapp, *Demographic Cultural and Personality Attributes of Scientists*. Psychological Laboratory, Wesleyan University, Middletown, CT.
- Calvin W. Taylor, *Some Possible Relations between Expression Abilities and Creative Abilities*. Department of Psychology, University of Utah, Salt Lake City, UT.
- Raymond Gould, *Some Comments on Creativity and Mental Health*. Professional Services Branch, National Institute of Mental Health, Bethesda, MD.

1957 Conference

- Calvin W. Taylor, *Some Variables Functioning in Productivity and Creativity*. Department of Psychology, University of Utah, Salt Lake City, UT.
- Donald W. Taylor, *Variables Related to Creativity and Productivity among Men in Two Research Laboratories*. Department of Industrial Administration, Yale University, New Haven, CO.
- B. S. Bloom, *Some Effects of Cultural, Social, and Educational Conditions on Creativity*. Board of Examinations, University of Chicago, Chicago, IL.
- J. P. Guilford, *Basic Traits in Intellectual Performances*. Department of Psychology, University of Southern California, Los Angeles, CA.
- Lindsey R. Harmon, *The Development of a Criterion of Scientific Competence*. Office of Scientific Personnel, National Research Council, Washington, D.C.
- Anne Roe, *Early Differentiation of Interests*. New York City.
- John C. Flanagan, *The Definition and Measurement of Ingenuity*. American Institute for Research and University of Pittsburgh, Pittsburgh, PA.
- Frank Barron, *The Needs for Order and for Disorder as Motives in Creative Activity*. Institute of Personality Assessment and Research, University of California, Berkeley, CA.
- W. A. Owens, *The Measurement of Creativity in Machine Learning*. Department of Psychology, Iowa State College, Ames, IA.
- Brewster Ghiselin, *Ultimate Criteria for Two Levels of Creativity*. Department of English, University of Utah, Salt Lake City, UT.
- Henry Eyring, *Comments on Creativity by a Physical Scientist*. Graduate School, University of Utah, Salt Lake City, UT.
- Ross L. Mooney, *A Conceptual Model for Integrating Four Approaches to the Identification of Creative Talent*. College of Education, Ohio State University, Columbus, OH.
- John R. Hills, *Recent Creativity Studies at Educational Testing Service*. Educational Testing Service, Princeton, NJ.
- Myron S. Allen, *The Working Procedures of Creative Scientists*. Technical Service Research, Long Beach, CA.
- Morris I. Stein, *Creativity and/or Success: A Study in Value Conflict*. Department of Psychology, University of Chicago, Chicago, IL.

1959 Conference

- Raymond B. Cattell, *The Personality and Motivation of the Researcher from Measurement of Contemporaries and from Biography*. Laboratory of Personality Assessment, University of Illinois, IL.

- J. W. Getzels and P. W. Jackson, *The Highly Intelligent and the Highly Creative Adolescent: A Summary of Some Research Findings*. University of Chicago, Chicago, IL.
- N. E. Golovin, *The Creative Person in Science*. Advance Research Projects Agency, Department of Defense.
- J. P. Guilford, *Intellectual Resources and Their Values as Seen in Science*. Department of Psychology, University of Southern California, Los Angeles, CA.
- Frank B. Jex, *Negative Validities for Two Different Ingenuity*. University of Utah, Salt Lake City, UT.
- Norman Kaplan, *The Relation of Creativity to Sociological Variables in Research Organizations*. University of Pennsylvania, Philadelphia, PA.
- Thomas S. Kuhn, *The Essential Tension: Tradition and Innovation in Scientific Research*. University of California, Berkeley, CA.
- Sidney J. Parnes and Arnold Meadow, *Development of Individual Creative Talent*. University of Buffalo, NY.
- Anne Roe, *Personal Problems and Science*. Harvard University, MA.
- Thomas B. Sprecher, *A Proposal for Identifying the Meaning of Creativity*. Psychological Service of Pittsburgh, PA.
- Calvin W. Taylor, William R. Smith, and Brewster Ghiselin, *The Creative and Other Contributions of One Sample of Research Scientists*. University of Utah, Salt Lake City, UT.

Beyond the individual presentations, the conferences set up committees to discuss the key issues on the future of creativity research. For instance, at the 1955 conference, aptitude, personality, and criterion committees were formed, and different group of researchers discussed and reported on current issues and future directions. The aptitude committee reported that new tests were needed for the assessment of creativity, and they should be able to measure integrative ability, ideational power, different manifestations of creativity, risk-taking, and decision-making. The group also recommended that new creativity tests should include different formats, such as verbal, nonverbal, possibly other senses, and analogies to create an inclusive assessment procedure. The aptitude committee addressed important principles for collaborative works in creativity research. Some of the issues were discussed in the committee, but the group was not in agreement; thus, they were reported as unresolved. They included the criterion problem in the assessment of creativity, the predictive variance for various levels of creative ability, devising creativity tests for different developmental levels, appropriate methods for analysis of creativity measures, and reliability and validity issues. Finally, the committees listed new areas for future research: creative test performance under different conditions such as the influence of drugs, gender differences, scoring procedures, the development of creativity in early ages, exceptional creativity in early ages and its persistency, group creativity, whether creativity can be learned, and the optimum level of creativity.

The personality committee sought answers to three questions: "What are the psychological characteristics of scientists in general? What are the distinguishing motives that separate creative scientists from uncreative scientists? What can we say about situational factors as they affect scientists in one type of environment as opposed to another?" Following discussions regarding the main questions, the committee had a brainstorming session about the characteristics of scientists. They came up with 24 attributes, such as impulsiveness, abstract thinking, autonomy and tolerance of ambiguity. Then, 24 attributes were clustered around 7 themes:

1. Manipulation of ideas.
2. The general quality of impulse control, repression of affects, isolation, and suppression.
3. Lower social involvement.
4. Autonomy and independence.
5. Tolerance to complexity and ambiguity.
6. A liking for things and a preoccupation with the physical universe.
7. Use of more sophisticated thought processes.

Their discussion indicated that these seven themes are common characteristics of creative scientists, and the level of each theme differentiates creative scientists from their noncreative colleagues. The committee reported that more research is needed to clarify the influence of social climate on creativity, career options for different characteristics such as industry versus academia, and the biological and cultural factors for creativity.

Finally, in the criterion committee, the members discussed a possible criterion measure for assessment of scientific creativity. Among several possibilities, measuring scientists' creative achievements or accomplishments emerged as a viable method. The committee reported that it could be achieved in two ways, one measuring overall achievement in science, and the other assessing a scientist's invention based on expert judges in the field. It was noted that noncreative accomplishments or nonscientific creative productions should be excluded from such assessment.

Relevance to Current Research

The Utah creativity conferences were important because they touched on topics that are still being debated today. For instance, the criterion committee and Joe H. McPherson addressed the criterion problem, referring to a lack of criterion validity in creativity

measures. In the creativity context, measures should predict certain abilities or behaviors. Using scientific creative products and expert judges was proposed by the committee and McPherson, but such suggestions needed to be adapted for other domains; and using judges for creative product evaluation needed further clarification and empirical studies before becoming a viable method.

More recent studies on the Consensual Assessment Technique (CAT), using expert judges for assessment of creativity on products, are in line with the issues discussed at the conferences. However, the definition and level of expertise and subjectivity of CAT are still being discussed in the literature. Measures on creative achievement and ideation, such as the Creative Activities and Accomplishment Checklist (CAAC) and the Runco Ideational Behavior Scale (RIBS), are also the result of the efforts to address the criterion problem in creativity. Another issue is the scope and definition of creativity. Since creativity is a multifaceted phenomenon, there is no consensus on its definition, and it is not likely that a single measure can capture all its components. As a result, there is an ongoing effort to develop a more comprehensive creativity measure/set of measures or improve the existing ones for best assessment practices.

The Utah creativity conferences may imply a paradigm shift in creativity research in the 1950s. As (Csikszentmihalyi 2015) argued, early studies investigating creativity predominantly focused on the concept of genius, which refers to exceptional creativity and intelligence. It was the common approach that creativity could be understood through studying factors in the individual such as cognitive processes, emotions, and motivation. Although the terms creativity and genius are closely related, all creative people are not necessarily geniuses, and not all geniuses produce creative products. Moreover, many social, economic, and cultural factors should be considered to develop a better understanding of creativity. In the presentations and discussions, there was an emphasis on socially recognized and breakthrough scientific productions, and the conferences urged researchers to conduct more studies on social context or the creative climate to develop a creativity-fostering environment for creative production. After the 1950s, there were a growing number of studies about the social psychology of creativity by researchers including Morris Stein, Dean Simonton, and Teresa Amabile.

At the 1955 conference, Raymond Gould from the National Institute of Mental Health talked about the connection between creativity and mental health. He argued that creative abilities and creativity in interpersonal relations may contribute positively to personal mental health. It was and still is a common myth that creativity is associated with psychopathology. Early studies on eminent creators repeatedly concluded that creativity is associated with madness, and such finding led to a negative perspective about creativity. More recent studies, however, show that creativity is a positive trait and connected with personal well-being. Despite the popularity of mad-genius hypothesis, Raymond Gould framed creativity as a strength for personal and community-level mental health. Many other presenters also addressed creativity as an important personal ability to boost creative production in science. Research regarding the use of expressive arts in healing has confirmed the value of creativity in working with individuals with mental health issues.

Conclusion

The Utah research conferences on the identification of creative scientific talent brought together outstanding researchers, psychologists, and psychometricians. They held valuable presentations and discussions on a variety of issues, such as the assessment of creativity, social and cultural factors, creativity and mental health, and the characteristics of creativity. Significant research questions and recommendations resulted from in-depth discussions for the future directions in the field.

As noted above, there seems to have been a nurture/nature paradigm shift in the 1950s, and several discussions and presentations elaborated on creativity and environmental conditions. The social psychology of creativity was, however, relatively new, and the existing research was mostly case studies in scientific institutions. There was a lack of research about environmental conditions for creativity, social-cultural climate, domain differences, and creativity in organizational and school settings. In their presentations, Benjamin Bloom, Lindsey Harmon, and Norman Kaplan emphasized that creativity does not occur in isolation, thus, social and cultural factors should be taken into account. The Utah Conferences inspired further research on these issues, and the publication of important research studies.

Another significant contribution of the conferences was increased understanding of the domain specificity of creativity. In Utah conference series, creativity in science was valued and emerged as a viable research field to improve scientific production and novelty in a competitive global setting. The criterion committee in the 1957 conference suggested that creativity is a complex and multifaceted phenomenon, so separation of different disciplines/domains is necessary to properly assess and evaluate creative potential and production. Presenters, like Guilford, Taylor, and Harmon, shared their thoughts on the characteristics of scientific creativity and their implications for the assessment. Discussions on scientific creativity, of course, opened new possibilities for other domains, such as creativity in interpersonal relations, organizations, entrepreneurship, and educational practices, and significantly contributed to the current discussion of domain specificity issue.

The conferences also touched upon many other issues, such as the intelligence-creativity relation, risk-taking, and the creative process. The in-depth presentations and discussions pioneered creativity research as a distinct and valuable field. The conferences led to an extension of the boundaries of creativity research, opened new directions and possibilities for the future of the field, and have had a lasting effect in the history of creativity research.

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Virtual Reality

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Definition of Virtual Reality

Virtual reality, as its name implies, is a combination of the definition of ‘virtual’ and ‘reality’. The word “virtual” is originally defined as things that exist in essence but not in actuality. With the development of information technology, it produces a huge amount of computer-generated information. Currently, the word “virtual” is frequently used to describe things that can be done or seen on a personal computer or a computer network. The word “reality” means actually existed things as opposed to imagination. Combining the two words, the term “virtual reality” refers to the use of computer modeling and simulation to present an environment or offer experience that does not really exist in a physical world.

The Technical Landscape of Virtual Reality

Like many other techniques in history, the earliest technological concept of virtual reality was proposed in science fiction. In 1935, an American science fiction writer Stanley Weinbaum released a science fiction story, *Pygmalion’s Spectacles*. In the story, a professor invents a pair of goggles transporting people into a fictional world in which he could have senses of sight, hearing, taste, smell, and touch. In the middle of the 1950s, a filmmaker Morton Heilig developed the first fully immersive virtual reality system, Sensorama. The machine combines a full color stereoscopic 3D video, an audio, a motional vibrating chair, and smell shots. The Sensorama provides an immerse experience for viewing films, which was thought as the cinema of the future. In 1960s, two engineers in Philco Corporation combined a magnetic motion tracking system with a video screen to develop the first motion-tracking head-mounted display, Headsight. The Headsight was used by the military to observe dangerous situations remotely. However, due to the weak capabilities of graphics processing units of computers at that time, these displays are only connected to cameras and cannot present virtual stimulated scenes generated by computer rendering. Until the middle of the 1960s, Ivan Sutherland, a computer scientist connected head-mount displays to a computer. He and his collaborators developed a head-mounted display (HMD) system, the Sword of Damocles, which allows users to view a virtual environment through HMD and interact with virtual objects (Sutherland, 1968). The Sword of Damocles is known as the first HMD system in history to present “virtual” environments generated by real-time simulation. However, due to heavy weights of virtual reality HMDs, virtual reality systems had not extended beyond laboratory projects for a long time until the middle of the 1980s. In 1984, Jaron Lanier and Thomas Zimmerman founded a company, VPL Research. This company is considered to be the first company to sell commercial virtual reality goggles and gloves to the public. They developed a series of virtual reality software and hardware, which are very close to virtual reality products in a modern sense, such as, an input device, DataGlove, a head-mounted display unit, EyePhone HMD, a 3D sound system, Audio Sphere, a real-time 3D visual rendering engine, Isaac and a visual programming language, Body Electric. These products are very close to modern virtual reality products, creating an integrated system of software and hardware to enable the application of virtual reality.

In addition to HMD, another type of virtual reality system is projection-based virtual reality, which creates a virtual reality experience via 3D projections. In the middle of 1970s, Myron Krueger, an American computer artist, established a virtual reality system defined as the Videoplace. The Videoplace used projectors and video cameras to create an interactive environment. To generate immersive experience, researchers at the Electronic Visualization Laboratory, the University of Illinois, combined multiple projection screens into a cube-like space. The system is named as Cave automatic virtual environment since its space is similar to a prehistoric cave painting. A typical cave system consisted of a cube-shaped room in which the walls, floors or ceilings are projection

screens. A user sits in the cue room watching a virtual environment through a 3D glass. He/she could interact with a virtual environment through input devices such as controller, body gesture or data gloves.

The second component of the virtual reality system is the input device by which a user interacts with a virtual world. Interaction in a 3D virtual environment is much more complicated than that in a conventional 2D display, involving object positioning, rotating, scaling. It is not very convenient to use a keyboard and mouse to manipulate objects in a 3D space. In 1981, Kensington launched a famous trackball mouse that contained a ball held by a socket. User rotated balls to position the cursor and rotate objects on a screen. A trackball mouse has been considered as one of the most efficient input devices for 3D modeling software. In the late 1980s, Colin Ware developed a six-dimensional mouse named bat (Ware and Jessome, 1988). The mouse used a spatial sensor with six degrees of freedom to signal orientation and position relative to a fixed source, which allows positional placement and angular placement. Researchers at Fraunhofer IMK developed a cubic mouse for users to specify three-dimensional coordinates in graphics interfaces (Fröhlich and Plate, 2000). The device includes a cube-shaped box with three perpendicular rods representing X, Y and Z axes in a three-dimensional space. A user pushes and pulls the rods to control positions and orientations of virtual objects in a 3D environment. In 1993, 3Dconnexion, a subsidiary of Logitech launched the first consumer 3D mouse, SpaceMouse, providing a comfortable and natural way to manipulate 3D models. The mouse is still popular today.

In addition, users normally stand or walk around when they interact with a virtual environment. In that case, there is no supporting surface to place a mouse or keyboard. Users have to carry interaction devices in interacting with virtual environments. Therefore, it is essential to design portable interactive devices in a virtual reality system. In early 1980, the Nintendo designed an entertainment system controller, which becomes a classic model of the modern game controller. The controller utilizes the cross-shaped joystick for direction controls and four buttons for menu selection. However, the cross-shaped joystick is not efficient for rapid movements in a 3D space. In 1996, Nintendo added a thumb-operated control stick into the middle of its controller, which allows a player to have 360 degrees of control of locomotion. A year later, Sony released a DualShock analog controller, the first dual analog controller for game consoles. The left stick controls a user's direction and movement and the right stick rotates the view direction of the camera. The combination of two sticks provides a very efficient way for a user to navigate in a 3D space.

In 2001, Microsoft stepped into the video game console business and developed an Xbox controller to compete Sony's PlayStation 2. The design looks similar to DualShock controller, including a cross-shaped joystick and two analog sticks for directional and camera viewpoint control. The layout of buttons is further optimized such as reversing the position of the cross-shaped joystick and the left analog sticks. The Xbox controller has become the gold standard for game controllers after continuous optimization in ergonomics in the last decade. In 2015, HTC Vive implemented the tracking technology to its controller and developed a completely new interactive system. The system consists of a pair of controllers. Each of them is equipped with 24 infrared sensors to detect the positions of the controller. The system allows users to interact and play with virtual worlds by moving or rotating their hands, which is much more intuitive than moving a cursor through a gamepad. Launch of HTC vive started a new era of interaction devices in virtual reality. Other major players in the virtual reality market such as Oculus and Sony followed closely the efforts that developed controllers with a similar technical framework.

Although these controllers provide an efficient way for users to interact with a 3D space, the interaction is still not natural. Moreover, holding controllers for a long time would also cause fatigue no matter how light they are. It is valuable to develop wearable devices for virtual reality applications. Data Glove offers a new way for users to interact with a virtual reality world, which allows users to put down controllers and interact with virtual reality games using their own hands. There are three different technical approaches for gloves: Fabric gloves, thimbles, and exoskeletons. In a fabric glove, flex sensors or optical fiber sensors are implemented into a glove to detect the degree of bending of each finger (McDowall et al., 2000). The movements of fingers collected by gloves are interpreted as input commands by a host computer in a virtual reality system. Given individual differences of hand size and hand shape, it is a very challenge to design adaptable gloves to fit the shape of the hands of an arbitrary user. Instead of covering hands and all fingers, the second type glove, thimbles only use several thimbles attached to a fingertip as sensors. Comparatively, thimble glove fits easily into hands with different sizes and shapes. However, it also raises the challenge to integrate many electronic components into a very light and compact device. The third type of glove is the exoskeleton, which is an articulated structure parallel to fingers on the outside of the hand (Caldwell et al., 1995). The structure could be adjusted to fit a variety of hand sizes and shapes. However, this also leads to a quite heavy and cumbersome mechanical structure, reducing its applicability and effectiveness. Due to these challenges and technical limitations, none of these gloves has won a great commercial success so far. In contrast, a more natural approach for human-computer interaction, vision-based gesture recognition gradually gained the attention of the industry (Moeslund and Granum, 2001; Rautaray and Agrawal, 2015). The system used digital cameras to acquire images of people's gestures and computer vision algorithms to interpret gestures as input signals. Although it cannot provide the same accuracy as data gloves, it meets the requirements of commercial products. They are many products implementing gesture-based recognition technology, such as the Xbox of Microsoft Kinect, SoftKinetic of Sony and Leapmotion.

In some of the virtual reality applications, users are not free to move their hands or bodies. It is important to develop techniques that enable hands-free operation in virtual environments. As humans tend to look at what they are willing to interact with, the human eye gaze is a natural and intuitive way of interacting with environments. Gaze control could be achieved through eye-tracking systems. A modern eye tracker normally uses infrared light to illuminate human eyes and capture reflections through a camera to determine where a person is looking (Tanriverdi and Jacob, 2000). The control system based on eye-tracking has been successfully used to aid people with physical disabilities to manipulate a cursor and click on icons on a screen. Recently developed eye-tracking sensors are sufficient to capture a real-time signal of a viewer's gaze point in high precision and small enough to be integrated into a head-mounted display (HMDs). In 2017, a Japanese company FOVE released the world's first virtual reality

headset with a built-in eye-tracking system, which shows the feasibility of integrating an eye-tracking system into HMDs. The other major players in the virtual reality market, such as Facebook and HTC, get started developing similar eye-tracking head-mounted displays. In 2016, Facebook acquired an Eye Tribe, a startup company which creates the first multi-platform eye-tracking solution for virtual reality applications. The technology is expected to be integrated into future Oculus virtual reality products. HTC has collaborated with a famous eye-tracking company Tobii and applied its eye-tracking technology into the new VIVE Pro Eye headset which has been launched in 2019.

Human speech is another hand-free medium to interact with machines. A voice-user interface (VUI) relies on speech recognition to understand users' spoken commands to enable hands-free interaction. In recent years, the accuracy of speech recognition has been greatly improved by machine learning technology and reached an acceptable level for most people even under certain noisy environments. Thus, VUI has become increasingly popular in intelligent devices, such as mobile phones, automobile's entertainment console, and smart home devices. Many large companies provide application programming interfaces (API) for speech recognition, such as Microsoft Windows Speech Recognition system, Google Cloud Speech APIs, IBM Watson Speech APIs. In 2017, Oculus integrated voice recognition into its HMDs to enable users to easily search and navigate in virtual environments.

Although virtual reality systems have been in development for many years, it is inaccessible for average users due to the high cost and poor user experience of virtual reality system. An HMD could easily cost \$20,000 in ten years ago and a CAVE-like virtual-reality device would even cost millions of dollars. Moreover, due to the limitation of technology in electronic, mechanical and optical engineering, these HMDs were too heavy for users to comfortably wear, resulting in poor user experience. Moreover, the conflicts between visually perceived movement in HMDs and the vestibular system's sense of movement result in motion sickness when a user wears HMDs. Thus, the applications of virtual reality have been mainly developed in the field of military or aerospace which are price-insensitive and have a high tolerance of unsatisfied user experience.

In recent five years, as the cost of virtual reality goes down and the application of virtual reality becomes more mainstream in consumer markets. In 2012, a start-up company Oculus made a huge leap forward for virtual reality. The company created a portable, self-contained HMDs with a weight of around 0.5 kg. The HMD provides a functioning virtual reality system, including two LED displays at a resolution of 1080×1200 , generating 110° field of view for an immersive experience (Desai et al., 2014). The system integrates a portable sensor to track the position of the HMD. Moreover, the system only cost around 300 dollars, which is cheap enough for average consumers to purchase and use at home. As one of the leading companies in virtual reality development, Oculus was purchased by Facebook in 2014 at two billion dollars, which boost the investment in consumer-oriented virtual reality products in the market. Progress of virtual reality technology offers social scientists a cost-effective tool to study human behaviors (Blascovich et al., 2002; Parsons et al., 2017; Zhou et al., 2019).

Virtual Reality and Creativity

Creativity is recognized as the ability to create something new or solve problems in novel ways. Creativity is one of the most precious talents of human beings. Understanding the ways of promoting creativity is important for improving the quality of education. Virtual reality technology could be an effective tool for creativity research and education given its advantage in creating unique virtual environment. First, it is well known that creativity is influenced by environmental factors. Living and playing in a rich environment may nurture the development of human creativity. Virtual reality technology offers a rich, vivid and immersive experience that generates powerful emotion to inspire human creativity. Passig and Eden (2000) found that playing 3D games in virtual reality increases the flexible thinking of disabled children. Hu et al. (2016) used creative thinking instruction such as the application of individualized instruction to facilitate human creative ability and found that using virtual reality could significantly improve the effectiveness of creative thinking instruction.

Second, the development of virtual reality technology offers an opportunity to create a standard and ecologically valid environment for assessing creativity. In virtual environments, stimulus parameters are easily manipulated, which provides convenience to investigate the factors affecting creativity in controllable testing environments. Minas et al. tested whether "openness" of the environment could affect creative thinking. The experiment constructed an open virtual space and closed room with a wall and roof and asked participants to perform brainstorming tasks in the space (Minas et al., 2016). They found that participants demonstrated higher creativity in open environments than that in closed rooms.

Third, virtual reality technology is also changing the way we present creativity. In innovation activities, human beings construct a new world in their minds through a lot of mental thinking and imagination. Virtual reality provides a fast, low-cost way to visualize people's thinking and imagination that could assist people in creative thinking activities. The technology would affect the way of working in creative industries such as advertising, architecture, design, fashion, film, and video. For example, artists could present their work in virtual reality to provide an immersive viewing experience for audiences.

Fourth, virtual reality technology can also be used to simulate some scenes that are difficult to achieve in real life, thus creating novel and different stimuli to improve people's creativity. For instance, using VR technology, Wang et al. (2018) built a scenario where subjects could break through walls to embody the metaphor of "breaking the rules", and found that participants generated more original ideas in the break-wall condition than in the no-wall condition. They also explored the neural correlates of this effect by combining VR and functional near-infrared spectroscopy (fNIRS), and found weaker activations in several brain regions under

the “break-wall” condition, including the frontopolar cortex, the dorsolateral prefrontal cortex, and the somatosensory association cortex (Wang et al., 2019). fNIRS offers high freedom in recording participants’ brain activities in various scenes, and it is compatible with VR equipment, which can better assist VR research.

In summary, virtual reality technology is a medium that is able to induce the experience of “presence” in a computer-generated world, and thus it can be used to simulate various and calculable experience. By designing targeted virtual environments to alter the individual’s experience, virtual reality technology could be a powerful tool for multitudinous research and education.

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Visual Perception

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Introduction

Humans are predominantly visual creatures. In evolutionary terms, the ability to detect and process electromagnetic radiation in the form of visible light is exquisitely adaptive, allowing us to perceive and understand distal aspects of our environment and to plan movements consistent with that reality (Palmer, 1999). Vision is so useful that eyes or eyespots have independently evolved at least 40 times in the history of the animal kingdom, and some 96% of animal species have some form of a complex optical system.

The process of visual perception is essentially one of interpretation. The key problem in perception is to go from the basic detection of a two-dimensional pattern of electromagnetic radiation toward a pragmatic veridical understanding of the environment. Much of the human brain is involved in efficiently processing diverse streams of visual information (including form, color, and motion) in order to establish a unified, stable, and comprehensible percept. While the processing of visual input can occasionally be faulty – witness the susceptibility to optical illusions – for the most part our brains execute perception seamlessly and unconsciously. This is especially impressive given the profound computational challenges of dealing with input that is inherently ambiguous, transient, or incomplete.

In the course of perceiving the visual world, we build up representations of optical or spatial information. These are also useful for tasks that go beyond our immediate needs for understanding and behaving in the local environment, including learning, mental imagery, and creative imagination. Aesthetic domains like visual art are most strongly associated with the creative use of perception, but this is also true of scientific domains.

This chapter discusses visual perception and information processing as they relate to human creativity. First is a description of the structure and functions of visual processing in the eye and brain. Then comes a discussion of how visual perception relates to creativity in a domain-general way, via psychometric efforts to measure visual creativity and studies of insight, imagery, and personality. An exploration of domain-specific aspects of creativity and visual perception follows – mainly in the visual arts, but in several other domains as well. The chapter concludes with some integrative remarks and a brief discussion of future research areas.

Organization of the Human Visual System

Processing Stages

To understand how visual perception relates to creativity, one must understand the basics of how the human visual system is organized. Visual perception proceeds as a sequence of processing stages occurring in different parts of the eye and brain (Palmer, 1999). Initially, light energy enters the eye, focused by the lens onto the inside rear wall of the eyeball, which is lined with millions of light-sensitive cells called photoreceptors. Photoreceptors are divided into two types: color-sensitive cones, which are concentrated in the fovea (the area of the retina corresponding to whatever location in space a person is directly looking at), and rods, which are more sensitive to low levels of light (but not to color) and which are distributed over the entire retina. Incoming photons strike individual photoreceptors, activating them and causing an electrochemical signal to be propagated through several layers of cells. During this

process, information from multiple photoreceptors is combined into doughnut-shaped center-surround receptive fields. Signals from all photoreceptors are eventually gathered together into the optic nerve leading out of the eye, through the subcortical region of the brain called the thalamus, and then to the occipital (rear) lobe of the brain.

Early cortical analysis of the visual signal in the occipital lobe consists of neurons that function as ‘feature detectors.’ These respond preferentially to bars of light in specific orientations. This is useful for identifying areas of discontinuity in the visual field, which typically indicate the edges of objects. After basic feature detection and analysis, visual processing splits into several parallel streams. These include the ventral stream, which passes into the temporal lobe and which performs object recognition, and the dorsal stream, which passes into the parietal lobe and which is involved with the guidance of actions and analysis of objects’ locations. The different streams of processing are eventually pooled into a unitary percept, or interpretation, of the visual world, which forms the basis of understanding and action.

This thumbnail sketch of the main stages and pathways of visual processing is extremely condensed. There are many other aspects of visual processing, including the analysis of motion and color, reciprocal connectivity between early and late stages of processing and between different streams of processing, the integration of information from other senses and toward motor output, and goal-directed executive control over visual and attentional processes. Beyond the psychological mechanisms that are directly used in perception, others act to transform visual or spatial information for other purposes. Component skills along these lines include visualization, mental rotation speed, speed and flexibility of closure, basic perceptual speed, and visual memory. Of these, perhaps only visualization, that is, the imagination of spatial forms and rotation of them in space, can claim evidence of being important for enabling creativity (Palmiero and Srinivasan, 2015), of which more below.

Relevance to Creativity

How do all these varied characteristics of the visual system relate to creativity? Arguably, the computational achievement of vision is itself a creative act, in that it must derive a meaningful interpretation of the world from markedly underdetermined input. However, other structural characteristics of visual processing also impact higher-level creative thinking. For instance, visual processing is sequential, following a logical progression from the pixel-like activation of retinal photoreceptors, to oriented lines, to increasingly complex multi-dimensional representations involving motion, color, texture, object identity and position in space, and potential action. This sequence provides a processing scaffold that is remarkable in its efficiency and unconscious quality – at first glance, features that might seem to work against the generation of novel or creative representations. Indeed, the lack of direct conscious access to early representations constrain how we organize our perception in the first place, and how our perceptual representations might be used in creative thought – see, for instance, a study of artists’ perception by [Perdreau and Cavanagh \(2011\)](#), whose answer to the provocative question of whether artists can see their retinas was a clear ‘no.’

However, perception is not purely a bottom-up (that is, input-driven) reaction to the environment. There are always some top-down guiding effects of context, expectation, knowledge, and assumptions. To some extent, humans can exercise attentional control over how and what we perceive. Executive control can thus significantly impact the synthesis and organization of perceptual representations, which in turn can form the basis for creative imagery, ideation, or production; the same may be said of perceptual processes during altered states of consciousness. Even at the neuroanatomical level, the division of labor evident in many aspects of visual processing – different streams analyzing form versus color versus location versus motion, for instance – can engender creative or aesthetic possibility.

Consider a few examples to drive this point home. One instance involves drawing skill, a critical component of visual artistry. Most people find realistic drawing very difficult. A venerable (but false) explanation for artists’ ability to solve this problem is that they employ an ‘innocent eye’ strategy, achieving accuracy by drawing only what they see, without any interference from their conceptual knowledge. In addressing this issue, [Gombrich \(1960\)](#) noted that the initial two-dimensional retinal image of a three-dimensional world necessarily involves a loss of information, which cannot be perceptually recovered without some top-down, or hypothesis-driven, influence. (This argument applies both to perception and the making of realistic art.) In contrast to this advice to ‘forget what you know’ in order to draw more accurately, Gombrich argued precisely the opposite: knowledge of the structure of appearances should be harnessed to more astutely select the information most critical for perceptual recognition. The multifariousness of visual processing gives artists diverse options in style choice, just as our visual system can be tuned to various perceptual ends based on our goals.

Two additional examples ([Livingstone, 2002](#)) reinforced how artists might use intuitive knowledge of the structure of the visual system to produce creative effects. First, the coy quality of Leonardo da Vinci’s *Mona Lisa* – who appears to smile only when a viewer looks away from her mouth – can arguably be understood in neuroanatomical terms. Specifically, the smile appears least evident at high spatial frequencies, that is, in the local detail we see when directly looking at something. However, the smile is more apparent at low spatial frequencies, that is, in the unfocused blur of our visual periphery when we look away from Mona Lisa’s face. Similarly, the flickering quality some viewers report when looking at Claude Monet’s painting, *Impression: Sunrise*, may be regarded as a consequence of the fact that Monet painted the red sun and blue-gray background in the painting at the same level of luminance, or brightness. Color processing channels in the brain can ‘see’ the sun, but black-and-white form channels in the brain cannot; this discordance in the outputs of the two streams induces a subjective perceptual flickering.

These examples suggest that the complexity and flexibility of the basic functioning of the visual system – including our capacity to generate internal representations via mental imagery – can be exploited to creative or aesthetic ends. The use of visual

imagination, which need not be directly tethered to real-time visual input, increases the creative possibilities of perception-related processes still further.

Domain-General Aspects of Visual Creativity

Theoretical Accounts

Several prominent theoretical accounts in psychology have emphasized the importance of the visual modality for creativity. For instance, [Gardner \(1983\)](#) accounted visual-spatial ability as one of his so-called multiple intelligences (along with mathematical, linguistic, musical, kinesthetic, interpersonal, and intrapersonal abilities). [Feist \(2004\)](#) argued that visual artistry is a fundamental 'domain of mind' that reflects longstanding evolutionary pressure, is culturally universal, and appears spontaneously in all normally developing children.

However, despite intuitive connections between perception and creativity, meaningful empirical linkages between the two have not always been strong. For instance, [Flowers and Garbin \(1989\)](#) reviewed extant research on the intuitive connection between perception and creativity and noted lacunae in both research and theory specifically focused on these issues. In a rare exception, [Shepard \(1981\)](#) argued for a close relation between perception and creativity, claiming that implicit knowledge of visual relationships among objects, and rules for transforming those relationships, may constitute basic creative operations of the mind. Shepard further argued that decoupling normally involuntary processes from their perceptual source may allow those mechanisms to contribute to creative thought. More recently, [Palmiero and Srinivasan \(2015\)](#) thoroughly reviewed research on creativity and spatial abilities but found relatively little evidence supporting strong links between these constructs, at least based on how they are typically assessed in psychological research.

Psychometric Approaches

The most enduring empirical tradition exploring visual creativity has been taken up by creativity researchers with a psychometric bent. The challenge here is to devise tasks that can be administered to the general population and that are not limited or tied to domain-specific knowledge in a discipline like visual art. Such assessments thus represent a domain-general way of assessing creative potential and creative ideation. These typically take the form of visual or figural tests of creativity, in which participants generate creative responses to some visual prompt. For many years, visual aspects of creativity have figured prominently in the creativity testing literature. For example, in a collection of 225 creativity tests by [Torrance and Goff \(1989\)](#), figural image-making tasks made up about 9% of the total items.

Figural tests of creativity are valued because they are a simple alternative to verbal tests of creativity and are ecologically valid and easy to administer, even to children. [Pelowski et al. \(2017\)](#) provided a thorough review of visual creativity tests, which come in several major forms. Probably the most common version involves 'figure completion,' in which participants draw from visual cues pre-printed on paper. Early examples included the Franck Figure Completion Test, consisting of 36 rectangular fields, each with a simple geometric or curved figure that is used as the basis of a more complex drawing generated by the participant. More recently, the Torrance Test of Creative Thinking (TTCT) has become probably the most widely used instrument; it has been used in some 75% of creativity studies testing elementary schoolchildren and 40% of studies testing college students or adults. The figural aspects of the TTCT include ten figure completion items that are similar to those of the Franck Figure Completion Test, a picture construction task in which participants complete a drawing and assign a title, and a lines/circles task in which participants draw as many uses for a simple image as possible. Performance is scored on measures like fluency (the ability to create many images), originality, elaboration, abstractness of titles, and resistance to premature closure (a tendency not to quickly close off cues). Performance can also be assessed on criteria like storytelling, movement and action, unusual visualization, and richness of imagery. The TTCT has also shown fairly good validity in predicting real-world creativity.

Several alternatives to the TTCT have also been developed. These tend to share some aspects of stimuli and scoring with the TTCT and include the Creativity Assessment packet, Wallach-Kogan Creativity Test, and the Test for Creative Thinking-Drawing Production – the latter with emphases derived from Gestalt psychology. Other researchers have used more open-ended drawing tasks from imagination as a way of assessing visual creativity. One is Clark's Drawing Abilities Test, in which participants make drawings of a horse, a running person, a playground, and the participant's 'fantasy.' This test appears to be a reliable standardized instrument to identify artistically talented students, with CDAT scores correlating with teacher rankings of student success in classes for artistically talented students. (For details on all these tests, see [Pelowski et al., 2017](#).)

Insight

Besides creativity tests that directly require participants to generate a novel depiction as a domain-general index of creativity, researchers have also pursued other, less direct approaches. One is rooted in the phenomenon of insight: those emotional 'a-ha!' moments when a person has some novel realization, which have long been associated with creativity. Notably, even the word 'insight' suggests a sensory link (in-sight), along with the potentially rapid changes of interpretation inherent in many visual perception processes. For instance, identifying the content of out-of-focus photographs is the best predictor of individual differences in insight performance; notably, [Kozbelt \(2001\)](#) found that visual artists outperformed non-artists on this perceptual task.

In the laboratory, researchers have used ‘insight problems,’ which typically require some sort of reframing to achieve a solution, as proxies for real-world a-ha! moments. Many of these problems are verbal in nature, but others are more visual or spatial. Famous examples include the nine-dots and matchsticks problems. In the nine-dots problem, nine dots in a square 3×3 array must be connected by four straight continuous lines. In the matchsticks problem, six matchsticks must be put together to form four equilateral triangles. Typically, solutions to such problems require participants to perceptually reorganize the stimulus to overcome some default bias or implied constraint in the problem. In the case of the nine dots problem, the constraint is the *Gestalt* formed by the nine dots, and the solution requires drawing the lines beyond the boundaries implied by the ‘square.’ In the matchstick problem, it is the two-dimensional presentation of the problem, and the solution requires making a three-dimensional pyramid with the matchsticks.

Achieving the perceptual reorganization necessary to solve such problems may require deliberate executive control or attentional flexibility; alternatively, the solution may arise more spontaneously from resting brain state activity. Such findings serve as a reminder that many aspects of neural processing, beyond the sequential stages of perception, impact creative thought. In passing, note that this point also extends to other forms of representations – linguistic, mathematical, kinesthetic, and so on – which also interact with perceptual processes and contribute to creative thought.

Imagery

The nature of the human capacity for generating internal visual representations has long been debated within the ranks of cognitive science – mainly in terms of whether such representations are ‘really’ visual, rather than being epiphenomenally so. Neuroimaging research has revealed that visual perception and visual imagery draw on most of the same neural underpinnings (Kosslyn et al., 2006), though the issue of what it would mean to characterize the ‘true’ nature of a mental representation remains a thorny philosophical issue.

The topic of visual imagery is of great interest for the study of creativity, as it has traditionally been anecdotally implicated as a driver of creative thought – particularly in the process of generating new ideas. Many empirical studies have sought to understand the role of imagery in creativity. Among the most prominent lines of inquiry is the so-called ‘creative cognition approach’ pioneered by Finke et al. (1992). This research proposed to understand creativity mainly in terms of the application of well-understood cognitive psychological principles and mechanisms, rather than resorting to more exotic modes of cognition as explanations. Of the many notable contributions of this approach, the notion of ‘pre-inventive structures’ is probably the most relevant for understanding the role of mental imagery in creativity. Pre-inventive structures are internal precursors to the creative act. They frequently have a visual component, often taking the form of symbolic visual patterns and diagrams or representations of three-dimensional objects. The role of such structures in the creative process have been investigated in numerous lab experiments. In one representative study, participants were shown a set of simple objects and were asked to combine them into a new invention, whose basic category (like furniture or vehicles) was specified either before or after they had put the parts together. Inventions judged as creative were more likely to occur when the basic category was specified after the parts were assembled.

Also relevant is other work within the creative cognition approach, an alien creature invention task developed by Tom Ward. In the basic version of this task, participants are asked to imagine traveling to another planet and encountering some alien life form. The task is simply to draw a picture and write a short paragraph describing the alien. Despite the almost completely unconstrained nature of the task, Ward and others have repeatedly found that participants evince little creativity, rooting their creatures’ characteristics mostly in line with those of familiar real-life or science-fiction examples. From the standpoint of visual perception and creativity, this ‘structured imagination’ taps into both perceptual aspects (recalling the appearance of specific exemplars from memory) as well as the interface between perceptual and conceptual knowledge (as in participants’ deployment of categorical knowledge in approaching the task).

In addition to research within the creative cognitive approach, other scholars contributed valuable concepts about the nature of creative imagery. For instance, consider two notions described by Rothenberg (1979): Janusian thinking and homospatial thinking. Janusian thinking is the ability to imagine and hold in mind two opposite or contradictory ideas, concepts, or images simultaneously. Homospatial thinking consists of actively conceiving two or more discrete entities occupying the same space, which can lead to the articulation of new identities. Such processes are often highly visual in nature, and Rothenberg identified numerous instances of visual artists engaging in such thinking. Laboratory research also revealed that artists presented with two superimposed images made more creative drawings than artists presented with similar but non-superimposed combined-composite control stimuli. While this latter result does not directly tap into internal visual imagery *per se*, it does suggest something of the fluid indeterminacy of imagery and its productive role in creative ideation (See Janusian, Homospatial and Sep-Con Articulation Processes).

However, despite an oft-touted anecdotal relationship between imagery and creativity, the overall empirical relation between the two appears to be rather slight. For instance, one meta-analysis of 18 papers on visual imagery and divergent thinking ability (Leboutillier and Marks, 2003) found that self-reported mental imagery was reliably associated with performance on divergent thinking scores but explained only about 3% of the variance in the data sets. Separate analyses of important characteristics of mental imagery and two types of divergent thinking showed similar effects across variations in question and test formats, suggesting only minimal support for the claim that mental imagery is an important correlate of creativity – at least when creativity is construed in divergent thinking terms.

Personality

Besides approaches in which creativity is characterized mainly via underlying mental processes, personality is another factor that has long been associated with creativity. Of the 'Big Five' well-established dimensions of personality, that of openness to experience is the most consistently and strongly associated with creativity, or at least creative potential (Feist et al., 2017). It is easy to see that someone who was neither curious about nor open to new experiences would be less likely to show meaningful creativity.

What does personality have to do with visual perception and creativity? Some research suggests incipient connections between the two constructs. For instance, openness to experience correlates with the ability to select 'aesthetically superior' pictures and with more positive ratings of abstract and representational art (see Pelowski et al., 2017). Recent research (Antinori et al., 2017) suggests that openness to experience is positively associated with an additional low-level aspect of visual perception – specifically, binocular rivalry, where the brain alternates between mixed and unmixed percepts. Participants higher in openness to experience showed longer mixed percept times, an effect that increased following a positive mood induction. While binocular rivalry is not a direct productive measure of creativity, it has parallels with homospatial thinking and is consistent with the idea that creative people perceive the world differently than less creative people.

Domain-Specific Aspects of Visual Creativity

The preceding suite of approaches represents a domain-general view of creativity. Modern discussions of creativity have long been characterized by debates on issues like the extent to which creativity is better considered as a domain-general or domain-specific phenomenon and how to consider different levels of creative achievement, ranging from minor personal insights to history-making achievements. When manifestations of creativity can be regarded as fundamentally greater, more impressive, or more impactful, they tend to be more domain-specific. So perhaps the quick-to-administer and domain-general laboratory tests of creativity described above are impoverished, trivializing the real phenomenon of interest.

A more meaningful characterization of creativity might require more elaborate testing conditions, more expert participants, and more domain-specific conceptions of creativity itself. How have researchers addressed the potential link between visual perception and creativity in more domain-specific ways?

Creativity in Visual Art

Art is a paradigmatic domain for the study of visual perception and creativity. There is a long tradition of using domain-specific artistic production tasks and artist participants to better understand the nature of creativity. Since the creative behavior of artists is often strongly rooted in visual response, artists' activities can inform aspects of their visual processing, even if these are not tested directly in a psychometric way.

One of the most seminal and widely cited study of creativity is that of Getzels and Csikszentmihalyi (1976), who studied college-level art students. Participants were given a display of objects and were asked to use them to set up an arrangement and to draw it, in any style that they liked. Getzels and Csikszentmihalyi introduced the concept of 'problem finding' to account for the more creative artists' discovery-oriented behaviors, like handling more objects (and those more intensively) prior to starting drawing or taking longer for the final structure of the drawing to become evident. Subsequent researchers have borne out many of Getzel and Csikszentmihalyi's findings. For instance, Kozbelt (2008) observed college-level art students at work on a similar still-life drawing task, but with more fine-grained video coding of the hour-long sessions. While the initial selection and handling of objects was associated with the ultimate judged creativity of the drawings, even more important was the amount of revision, erasing, and reworking while drawing: more revisions were associated with greater creativity. Other studies used creative tasks involving collage or logo design, as well as structured interviews, to assess other aspects of the structure of artistic creativity, with similar results (for a review, see Kozbelt, 2008) (See Problem Finding).

A complementary line of research looked at the in-progress states of emerging works of art, either in the laboratory or by using the photographic evidence of acclaimed works by eminent artists. In line with other research on artistic creativity, a central finding from such studies is that artworks often undergo substantial visual changes as they progress. Such changes go beyond the mere filling in of predetermined elements and include significant alterations to the structure of the overall composition and the redeployment of many visual features throughout the process of creation. Sessions leading to more creative final outcomes tended to be characterized by a greater fluctuation in quality as they progressed, compared to 'safer' drawing sessions, which did not take as many risks, change in quality in a more linear way as they progressed, and ended up being judged as less creative final products.

What is perhaps most interesting here is the pervasiveness and intensity of many artists' revisions, given that in an ill-defined domain like art, there is no logical requirement for making such changes. Instead, these revisions emerged from artists' own creative standards and sensibilities and reflected their striving to achieve complex aesthetic goals. These goals were expressed through artistic media whose control depends on extensive domain-specific experience and knowledge. Importantly, revisions were mediated by what appear to be very flexible underlying perceptual processes, with both creative and evaluative components. Such results are consistent with general findings on experts' big-picture sensibilities on domain-relevant tasks and with creators' general willingness to take risks and make revisions to works-in-progress.

Perception in Visual Art

Besides studies that explore artists' creative processes, another line of research has focused on artists' perceptual abilities. Visual perception involves a general sensory modality; domain-specific creativity in art exploits some subset of visual processes that are relevant to that domain. Artists need to be able to perceive the visible world in special ways, which lend themselves to creating depictions that reflect those perceptions as expressed through specific artistic media. If artists routinely look at the world with the goal of rendering it, certain kinds of perceptual abilities may become enhanced. Overall, domain-specific expertise has substantial effects on experts' perceptual processes, particularly for familiar stimuli within their domain. Learning in complex domains involves learning to *see well*: that is, tuning perception to highlight task-relevant features and deep (rather than surface) properties, attending to important aspects of problems to control the time course of reasoning, and recruiting and restructuring neural regions to accomplish skilled perceptual tasks (Landy, 2018).

In recent years, numerous studies have documented and explored the nature of artists' perceptual advantages over non-artists – that is, how artists learn to see the world differently. For instance, Kozbelt (2001) found that not only did artists draw more accurately than non-artists, but they also outperformed non-artists on several visual perception tasks requiring visual analysis – like recognizing the subjects of blurry photographs – but which had nothing *per se* to do with drawing. Drawing performance and perception performance were positively correlated, and partial correlational analyses suggested that artists' perceptual advantages are developed mainly to the extent that they are useful in drawing. Subsequent research has largely corroborated these findings, while refining which aspects of perception typically yield differences, and deepening the underlying theoretical treatment (for a review, see Kozbelt and Ostrofsky, 2018). Among the robust results on artists' visual advantages are a more flexible top-down deployment of attention, enhanced recognition of degraded visual stimuli, better visual memory, and a greater understanding of the structure of objects. Evidence for purported advantages in lower-level aspects of visual perception and cognition – like overcoming perceptual constancies or the effects of visual illusions – is more mixed (Perdreau and Cavanagh, 2011).

Such research suggests that advantages in many aspects of visual perception and cognition are characteristic of a prototypically 'creative' group of people, visual artists. While these results are suggestive of an association, more research is needed to corroborate this point in a meaningfully domain-specific way.

Visual Perception in Other Domains

What about other domains? Beyond visual art, the relation between perception and creativity has also been explored. One long-standing assertion is that imaginative visualization processes can be useful for engendering major creative insights: August Kekulé's conception of the ring structure of the benzene molecule via a dreamy vision of a snake biting its own tale is prototypical here. While such anecdotes are suggestive, stronger evidence, involving somewhat more systematic investigation of these issues, has also been undertaken.

For instance, the psychological research literature on expertise suggests that in many domains, experts learn to pay attention to important aspects of problems. The extent to which gaining expertise in a domain literally changes the way a person perceives domain-relevant stimuli is a nuanced question. However, since many aspects of perception can be modulated through experience, it makes sense that deep knowledge of a domain could influence perception and thus impact potential creativity – though the details of this dynamic remain murky (See Expertise).

Beyond basic perceptual functioning, other facets of visualization are also important in domains outside of art. One aspect that has been studied extensively is the role of diagrams and other simplified external representations, which focus attention on the important attributes of a situation (Tversky, 2011). The ability to understand and to generate such representations calls upon varied visual and spatial skills. The empirical consistencies found among such representations shed light on how people think and have practical implications for pedagogy and for creative design processes.

In terms of more broadly conceived individual differences related to perception, spatial reasoning – that is, the ability to generate, retain, retrieve, and transform well-structured visual images – has been the subject of considerable recent research. Spatial ability is often considered a key attribute of intelligence as well as creativity – perhaps especially in mathematical, scientific, and engineering domains (Palmiero and Srinivasan, 2015). In an important and very large-scale ($N = 400,000$) longitudinal study, Wai et al. (2009) found that a high level of spatial ability assessed during adolescence remained a salient psychological attribute among those who subsequently achieve advanced educational credentials and occupations in STEM domains. Such results provide strong support for the notion that spatial ability plays a critical role in developing expertise in STEM domains. They also underscore the diversity of ways and domains in which perceptual factors may play out in terms of creativity.

Conclusion

While the topics of creativity and visual perception have each been pursued independently by researchers, links between them remain somewhat elusive – especially links based on direct, robust, and rigorous research. However, several converging lines of evidence broadly support the importance of perceptual and visualization processes for creative productivity. These lines of evidence encompass both domain-general and domain-specific approaches, the latter including artistic and STEM domains. While some thorough literature reviews and meta-analyses suggest that links between visual-spatial ability and creativity may be weaker than

previously thought, it is important to note that considerable research still needs to be done. Greater consistency and replication efforts among future studies – which have historically targeted different tasks, abilities, domains, and kinds of participants – should yield a more precise and nuanced assessment of the real links between aspects of perception and aspects of creativity. Especially informative would be studies grounding specific perceptual abilities in the dynamic activity process of high-level creators working on complex, ecologically valid creative activities.

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Voting

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Introduction

Democracy, a term coined by Greeks thousands of years ago, was and still is what people in different parts of the world seek. Democracy is defined as 'a system that provides citizens with political rights which they are free to exercise in a political structure open to public participation and electoral competition' (Trantidis, 2017, p. 67). When properly practiced, democracy ensures that all citizens have equal rights to participate in the decision making process that affects their personal well-being and nation. The salient feature of democracy is *voting*. The Oxford English Dictionary defines voting as 'A formal indication of a choice between two or more candidates or courses of action, expressed typically through a ballot or a show of hands.' Voting can be considered a double-edged sword: it can bring to power a Hitler or a Mandela. Both came to power by appealing to voters to accept their ideals and vision. Although the term voting is not restricted to politics (e.g., people might vote for a place to have a dinner or vote for the best idea to solve a particular problem), its significance in politics surpasses any other aspect of its use in the social world.

The focus of this article is on voting as a political tool and how creativity is affected by such a tool. What does voting have to do with creativity? To answer this question it is important first to shed light on the characteristics of a creative individual. This will help understand the relationship between creativity and political party; that is, the effect creativity has on an individual's preference to select a particular political party. The essay presents recent investigations that discern the relationships among conservatism, liberalism, and creativity, as well as new evidence showing how the party in power affects research funding. The summary section suggests a new term to distinguish between the good and the bad use of voting as a significant democratic tool, that is, 'the creative vote.'

Characteristics of Creative People

The scientific study of creativity began in the mid 20th century. Now, after 70 years psychologists and educators have a better understanding of this exceptional human ability. It is important to emphasize the 'scientific' aspect of creativity research, for two reasons. One, the term 'scientific' indicates that researchers use rigorous methods to test different hypotheses and to answer research questions. Two, people need to know that research findings in this field are reliable and based on scientific facts (Runco, 2019).

Since creativity is not a unidimensional ability, the study of creativity encompasses different perspectives and different approaches to understand creativity such as creative process, creative product, creative environment, and creative personality. This paper claims that the creative personality is an important element when discussing the relationship between creativity and the selection of a political party. What do scientific studies on creative personality tell us about the characteristics distinguishing creative individuals? Luckily, research on this topic abounds and there is a consensus that creative individuals are imaginative, curious, independent, original, willing to take risks, unconventional, flexible, open to experience, and tolerant (Feist, 1998; Feist and Barron, 2003). Among these characteristics, openness to experience, and tolerance are of high importance when discussing the relationships among creativity, conservatism, and liberalism. In all democratic countries there are at least two political parties, which is a healthy, given that diversity is good for creativity. Diversity allows people to discuss issues from more than one perspective. In a recent study on the relationship between creativity and conservatism, Runco et al. (2017) reported that creativity was positively related with racial diversity. Also, the second characteristic tolerance was among the highly correlated personal variables. Tolerance is one of the 3 Ts in Richard Florida's theory of creative class. Florida defined tolerance as 'openness, inclusiveness, and diversity to all ethnicities, races, and walks of life' (Florida, 2003, p. 10). Tolerance is linked to creativity because it allows diversity, and diversity is good for creativity. Tolerance is also important for originality since original ideas are nontraditional and uncommon, which requires risk tolerance (Runco, 2019).

Political parties, regardless of country, can be placed on a continuum ranging from left-wing (highly liberal) to right-wing (highly conservative). Examples of liberal parties are the Democratic Party in the United States and the Labour party in the United

Kingdom; conversely, the Republican Party and the Conservative Party are examples of conservative parties in United States and United Kingdom, respectively. One of the definitions for the term conservatism is ‘The quality of not usually liking or trusting change, especially sudden change’ (Cambridge Dictionary). Conservative people tend to be less flexible, less tolerant, and not in favor of change. This is exactly opposite to creative traits mentioned previously. A number of investigations have showed that conservatism and creativity are negatively related with each other. To put it differently, ‘the more conservative a person is, the less likely it is that he or she will do creative things’ (Runco et al., 2017, p. 331). That is not to say that people following conservative parties have fewer creative abilities compared with those in liberal parties. That is why personality should be considered, because we behave based on our beliefs and values. People who do not value creativity will not activate their creative potential. This argument is supported by number of investigations cited in the next section.

Conservatism, Liberalism, and Creativity

Several empirical methods have been employed across studies that examined the relationship between creativity and conservatism. In some recent investigations, voting patterns were used to estimate liberalism and conservatism (e.g., McCann, 2011a; 2009; Runco et al., 2017). Each US state was determined to be open (liberal) or conservative based on the winning party in that state – Democrat or Republican. Creativity was based on the number of patents granted per state, with conservatism being based on the percentage of Republican votes per state.

McCann (2011a,b), for example looked at the relationship between creative productivity, operationalized as the number of patents granted per state, and conservatism, operationalized as the percentage of Republican voters (for George W. Bush) in 2004, with openness being measured by The Big Five personality questionnaire. Patents per state was positively correlated with openness ($r = 0.50$) and negatively correlated with conservatism ($r = -0.65$). McCann concluded, ‘it is quite clear that patents are more likely to be issued to residents of states in which there generally is a lower level of conservatism’ (p. 342). In another study, McCann (2011a,b) used Richard Florida’s Creativity Index scores (3 Ts: Talent, Technology, and Tolerance) to assess the relationship between openness and conservatism. The Creativity Index scores of participants in each state captured openness, with conservatism measured by the percentage of George W. Bush voters in the 2000 presidential election. The same conclusions were reached: conservatism was negatively correlated with creativity, while a positive relation exists between creativity and openness. McCann’s findings were confirmed by Runco et al. (2017), but in these study counties were the unit of analysis instead of states. Runco et al. (2017) obtained voting data from 2581 counties in the United States and patents granted in each of these counties between 2011 and 2015. Conservatism was measured as the percentage of voters who voted Republican in the 2016 Presidential election. Again, creative accomplishment was negatively correlated with conservatism.

Jost et al. (2003) conducted a meta-analysis study looking at variables predicting political conservatism. Their results indicated that conservatism was negatively correlated with openness to experience ($r = -0.32$), uncertainty tolerance ($r = -0.27$), and positively correlated with intolerance of ambiguity ($r = 0.34$). Their meta-analysis covered 12 countries: United States, England, New Zealand, Australia, Poland, Sweden, Germany, Scotland, Israel, Italy, Canada, and South Africa.

Dollinger (2007) also studied the relationship between creativity and conservatism. He used the Creative Behavior Inventory (CBI) to assess creative accomplishment, The Big Five Inventory to assess openness, and Consensual Assessment Technique (CAT) to assess a figural divergent thinking test. In this study, conservatism was assessed by using Henningham’s C-scale, which is a 12-item scale of social conservatism. Openness, creative achievement, and creative products negatively correlated with conservatism: ($r = -0.27$), ($r = -0.22$), and ($r = -0.27$) respectively. The following section offers further evidence supporting the claim that creative productivity negatively correlates with conservatism. In this overview of national research grants, the number of awards used becomes a measure for creative productivity, while the party in power becomes a measure for conservatism.

New Evidence from NSF Research Grants

The question this section aims to answer is whether Republican leadership (conservatism) negatively affects the number of research grants. To answer this question, grants offered by the National Science Foundation (NSF) were counted for the period 1981 to 2016. Data dated earlier than Ronald Reagan’s presidency (1981) were incomplete. This search covered twenty-six years in which five US presidents took office. The least number of awards occurred in 1982 (6070) and the highest number occurred in 2009 (15,581). Since 1981, the NSF has funded 370,372 projects [awards] with 188,503 awards distributed over the 20 years in which Republicans were in power; conversely, there were 181,869 awards distributed over the 16 years that the Democrats were in power. As Fig. 1 shows, the average number of awards per year for Republicans was 9425.1 (45.33%), while the average number of awards per year for Democrats was 11,366.8 (54.67%). On average Republican conservatism accounts for a 1941.7 decrease in NSF projects funded per year.

A closer look at the number of awards since 2001 shows that the number of awards granted during George W. Bush’s presidency ranged between 10,427 and 12,054 whereas the number of awards granted during Barack Obama’s presidency ranged between 11,568 and 15,581 (see Fig. 2). This adds to the evidence that conservatism is negatively associated with productivity operationalized as the number research awards funded by the NSF.

NSF Awards 1981-2016

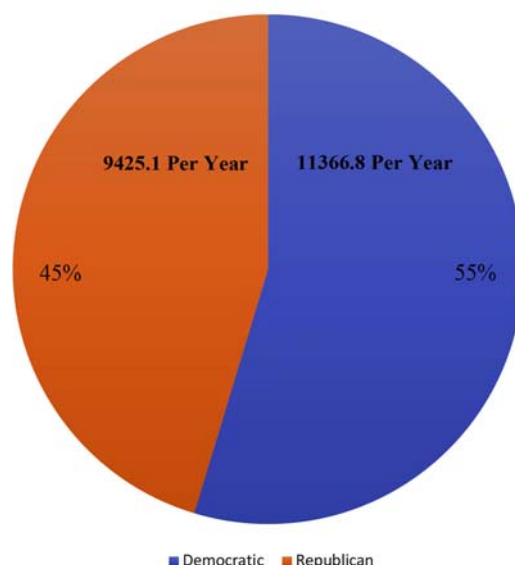


Figure 1 The Number of Awards Per Year for Republicans vs. Democrats (1981-2016)

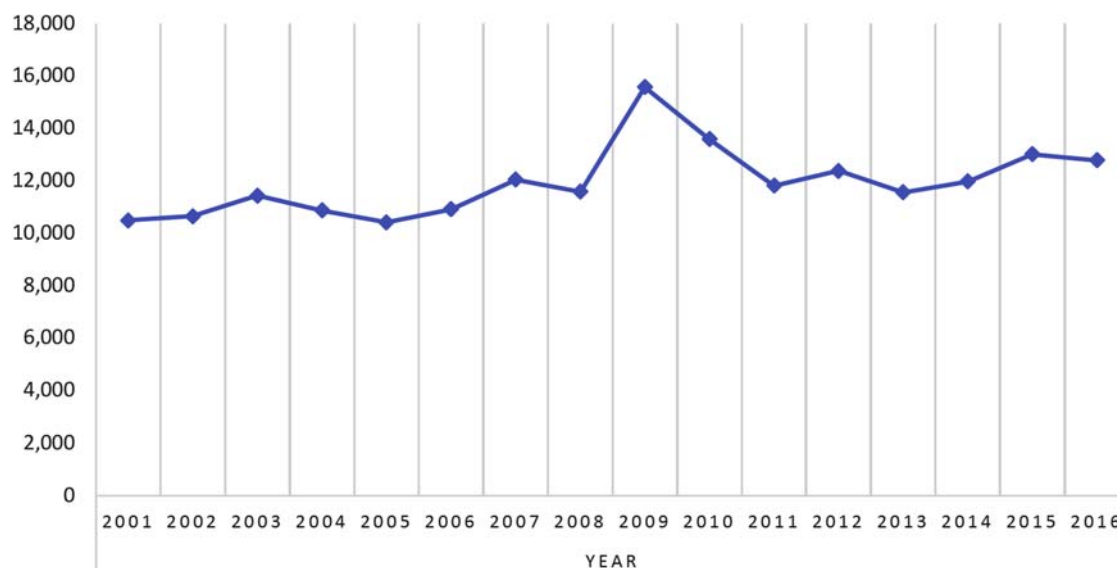


Figure 2 The Number of Awards Granted by NSF (2001-2016)

Conclusion

The previous sections explored the relationships among creativity, liberalism, and conservatism. There are many reasons that voters may expect less creativity from conservative people and parties. Conservatives conform to what is conventional, they focus on traditions, prefer stability, and resist change. This is just the opposite of creative thinking, which is characterized by originality, unconventionality, flexibility, tolerance, and openness. In fact, liberal versus conservative behavior is driven by two different motives; the desire to create versus the fear of change.

This chapter presented several studies that investigated the relationship between creativity and conservatism. Although different empirical methods were used to examine the relationship, the conclusions were the same: liberal thinking has a positive impact on creativity, while conservative thinking has a negative impact on creativity.

Practicing democracy in this chapter, it is the people's decision whether they vote for a person or a party that values creativity, and thus, encourages originality; or vote for a person, or to a party that maintains the status quo, and thus, encourages conventionality.

In other words, people need to decide between a creative versus uncreative vote. The former resulted in bringing to power people who support and encourage creativity, while the latter results in bringing to power those who are intolerant and distribute the culture of fear.

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W

War[☆]

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Introduction

Is personal and societal creativity positively associated with peace and prosperity? How does warfare affect the creative output of a given individual or nation? Does war determine both quantity and quality of cultural and intellectual activity?

A superficial glance at history might lead us to suspect that war features positive relation with creativity. At the individual level we might cite the example of Ludwig van Beethoven: Many of his masterworks seem to have appeared during the height of the Napoleonic Wars. Indeed, he had originally planned to dedicate his Third “Eroica” Symphony to Napoleon himself. [see Beethoven] At the societal level we might mention the Golden Age of Greece, a period of high cultural achievement framed by the Persian and Peloponnesian Wars. The Italian Renaissance provides another apparent example. Did not Leonardo da Vinci devote part of his creativity to designing weapons? And did not Michelangelo help design fortifications? Of course, it is also possible to come up with counterexamples. On the one hand, the famed Pax Romana – a period of relative peace during the Roman Empire – also was associated with a great cultural florescence, such as the so-called “Silver Age” of Latin literature. On the other hand, it would seem that World War II had a devastating impact on creativity in Europe and Asia.

Rather than continue to pit one anecdote against another, it is possible to address this question in a more objective and quantitative manner. In particular, the optimal approach is to apply historiometric methods to biographical and historical data [see Historiometry]. Fortunately, a large number of diverse studies have been conducted on this issue. The vast majority of these investigations focus on how war might influence creativity, so that research will be discussed first. But a smaller number have looked at how creativity might be involved in war, a possibility examined toward the end.

Effects of War on Creativity

In general, war can affect creativity in two ways: quantitative and qualitative. The first concerns the actual output, such as the number of creative products produced in a given year. Does warfare help or hinder the odds that creativity will appear? The second concerns the nature of the output, such as its thematic content or stylistic characteristics. Does peacetime creativity look different than wartime creativity?

[☆] *Change History:* Jan 2019. Dean Simonton updated the text throughout the article.

This article is an update of D.K. Simonton, War, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 509–514.

Quantitative Effects

How does war affect creativity? It turns out that this question is much more complex than first meets the eye. Research cannot begin to provide an answer until the investigator first responds to three subsidiary questions.

First, what exactly is meant by war? At the very least two different kinds of war can be distinguished. On the one hand are the wars between sovereign states, such as World War I among several European nations. This type of conflict is sometimes referred to as an international war. On the other hand are the wars that take place within a given sovereign state, such as the English Civil War of the mid-17th century. This type of conflict is sometimes called an intranational war. However, these two labels do not exhaust all of the possibilities. For instance, another kind of war is the imperialistic or colonial war where one modern nation-state subjugates foreign peoples, especially those who have a tribal rather than national political structure. Needless to say, different varieties of war need not have the same impact on creativity. Complicating the situation all the more is the issue of how to assess the state of war. Is it merely a matter of counting the number of nations that have declared war? Or should the number of pitched battles or war casualties be taken into consideration? What about the war's economic costs?

Second, what exactly is meant by creativity? It has become customary to distinguish between two levels of creativity, "little-c" or everyday creativity and "Big-C" or genius-level creativity [see *Everyday Creativity*]. War might not exert the same influence on both. In addition, it is obvious that creativity appears in many different disciplines. At the very minimum, scientific creativity must be separated from artistic creativity. Yet it may be necessary to make finer distinctions as well. Certainly more expensive art forms like architecture might suffer more from military conflict than less expensive forms like poetry. In the case of the sciences, applied disciplines like medicine and technology may receive a boost at the expense of pure disciplines like botany and mathematics.

Third and last, what is the unit of analysis? This turns out to be a very complex issue. To begin with, the investigator must decide whether the units are going to be individual or aggregate. Individual units concentrate on samples of creators or their creative products. Such units are designed for asking whether people are less creative if they grow up in wartime conditions. In contrast, aggregate units concern samples of individuals organized into larger entities, such as nations or civilizations. Such units are best for addressing whether societies that more often engage in war are more likely to have fewer creative geniuses. Another issue is whether the units are to be cross-sectional or longitudinal. Cross-sectional units could entail samples of individual creators or independent nation states. Longitudinal units, in contrast, would examine one or more units across time, where those units may be either individual or aggregate. For example, a researcher might examine how war affects the annual output of creators or nations. Most often the units are arranged into time series and thus subjected to some kind of time-series analysis. Whenever time series are used, the investigator must decide on the size of the longitudinal unit. The most common choices are years, decades, or generations, where the latter is taken as somewhere between 20 and 25 years in length. Shorter time-series units are optimal for studying the momentary effects of war whereas longer units are optimal for studying the more enduring consequences of war.

The answer to these three questions largely determines the empirical results. Indeed, the one secure conclusion that can be drawn from the literature is that the relation between war and creativity depends on the definitions of war, creativity, and the units of analysis. To appreciate this dependence, below I report the key findings under two headings, aggregate units and individual units.

Aggregate Units

Some researchers have counted the number of creative geniuses appearing in consecutive generations in the history of an entire civilization, where the creativity could come from any major domain in the arts and sciences. The fluctuations in these counts were then compared with the occurrence of international wars (sometimes weighted by the number of casualties). The same findings have appeared for both Western and Eastern civilizations: Military conflicts among independent states have no relation, positive or negative, with societal creativity. This null result explains why it is so easy to find examples of creativity under wartime conditions and creativity under peacetime conditions. Both possibilities occur with roughly equal likelihood.

Even so, by various changes in the methodological design, it becomes possible to observe some variety of war-creativity connection. For example, [Simonton \(1980\)](#) scrutinized the relation in Western civilization since the Renaissance, but introduced the following changes: (a) the unit of analysis was the year rather than the generation, (b) creativity was restricted to science and technology, (c) the creativity measure entailed an annual count of discoveries and inventions rather than individual scientists and inventors, and (d) war was split into four different categories, namely balance-of-power (or international) wars, civil (or intranational) wars, imperial (or colonial) wars, and defensive wars (when Western civilization was under attack by a non-Western civilization, such as the Ottoman Empire). In this case, negative effects were observed for balance-of-power and defensive wars. Over all, the following balance-of-power wars had the most destructive effect on discovery and invention in modern Western civilization: the Thirty Years' War, the Napoleonic Wars, and the two World Wars. Other inquiries have replicated this finding, particularly in the case of World Wars I and II. The latter even had an adverse effect on creative contributions in psychology.

The preceding studies concentrated on the concurrent or contemporaneous relation between societal creativity and war. The amount of war in a given year was directly compared with the number of discoveries and inventions in the same year. Yet it is also possible that the causal relation between the two variables is time lagged. That is, the impact is not immediate but rather manifests itself after a decade or more. This possibility has been tested using generational time-series analysis. In this technique historic creators and political events are tabulated into consecutive 20-periods called generations. The number of creators in generation g can then be correlated with the event counts in generation $g - 1$, or 20 years earlier. Because creators are assigned to the time-series units according to their peak productive

period (most often taken as age 40), creators in generation g would be in their developmental phase in generation $g - 1$. Hence, this time-lagged function can assess whether certain political events, including war, exerts an effect on creative development.

Although the allowance for time-lagged generational does not alter the picture for international war, the provision does change conclusions for various kinds of intranational war. Most prominently, revolts and rebellions directed against the hegemony of imperial states tend to increase the level of creative activity in a civilization. It seems that large empires tend to enforce a degree of cultural homogeneity that is antithetical to creative development. Interestingly, another kind of internal violence, namely, political instability, can have the opposite effect after a generation delay: 20 years after military revolts, coups d'état, and political assassinations a civilization tends to witness a decline in the number of creative geniuses.

One peculiarity deserves special mention: The impact of the diverse varieties of warfare depends on the domain of creativity under scrutiny. Most notably, creativity in the arts tends to be less affected than creativity in the sciences. Scientific creativity may require more ideal conditions than artistic creativity.

Individual Units

The empirical findings reported in the previous section all depended on data aggregated across large numbers of creative individuals. Indeed, many of the investigations tabulated thousands of geniuses into 20-year generational time series. It is conceivable that such aggregation obscures the relation between war and creativity. Especially in a large civilization area, some creators will be more directly affected by war than others. While World War I was quite injurious to creativity in Europe, its consequences for creativity in the Americas was minimal. Thus, it might be better to investigate how war affects creativity at the individual rather than aggregate level.

Unfortunately, far fewer researchers have taken this alternative approach. [Simonton \(1977\)](#) examined creative output in 10 top classical composers and still found that international war had no influence one way or another. Another study, using a very similar design, [Simonton \(1985\)](#) showed that the creative output of 10 top psychologists declined during times of international war. Both of these investigations counted output in 5-year periods across each creator's career. Potentially even this degree of aggregation may mask the more transient effects of war. For instance, [Borowiecki \(2014\)](#) counted the output of 115 classical composers in annual units, and thereby identified war effects (albeit the specific effect depended on the type of war). Yet another alternative is to use an even finer unit of analysis, namely individual creative products. For instance, [Simonton's \(1986a\)](#) study of 1935 compositions in the classical repertoire found that the most frequently performed works are less likely to be created during times of international war. So this particular form of artistic creativity may be encouraged by peacetime conditions.

Qualitative Effects

Even though certain types of war appear to have quantitative effects on specific kinds of creative activity, these effects are weak. Seldom is a military conflict so extensive that it shuts down creativity altogether. Because some creators will reside sufficiently far from the war zone, creative products will still appear, even if at a reduced rate. Consequently, it becomes possible to ask whether the works that appear in times of war differ from those that emerge in times of peace.

Various historiometric studies have addressed this question using an even more diverse set of methodological approaches. Probably the most important difference is the domain of creativity that is under investigation. Clearly, the thematic and stylistic parameters of creative products are contingent on the domain of creativity. For instance, a musical composition cannot be assessed by the same criteria as a scientific journal article. Accordingly, it is optimal to organize this section according to creative domain. More specifically, the discussion here will separately cover music, literature, and philosophy, and science. The visual arts appear to be missing from this survey, but there appear to be no published studies of how war might affect the style or content of paintings, sculpture, and architecture. Perhaps this omission reflects the difficulty of analyzing the visual arts for this purpose.

Music

One approach to assessing the qualitative effects of war is to apply content analysis to creative products that are generated under either wartime or peacetime conditions. The content analysis may take two major forms: subjective and objective. Subjective content analysis requires trained human judges to apply well-defined coding schemes to a given document or artifact. In contrast, objective content analysis requires that a computer program apply the coding schemes without the intervention of a human being. Both of these approaches have been applied to compositions that make up the classical repertoire. The empirical research using these methods has shown that music is often responsive to the stresses and strains occurring in a composer's personal life. And it is hard to imagine war having any less of an effect. In point of fact, investigations have indicated that concurrent warfare has a major impact on the stylistic content of compositions. For example, according to [Simonton \(1986a\)](#), compositions penned during wartime exhibit much greater variation in melodic originality; extremely predictable and extremely unpredictable themes being found in the same work. It is almost as if highly stressful contemporary events polarize the creator's emotional reactions, inspiring vast mood swings between resignation and despair, hope and fear. Furthermore, [Cerulo \(1984\)](#) found that the stylistic impact of war appears to intensify to the extent that the composer resides close to the actual war zone. Shostakovich's Leningrad Symphony, written during World War II, may provide a graphic auditory example of the magnitude of this polarization of trite and profound in melodic material.

Given that classical music constitutes a relatively abstract form of artistic creativity – where style seems more crucial than content – it might seem surprising that compositions are so responsive to external conditions like war. In the next domain of artistic creativity such a connection would be more likely expected.

Literature

Ben Jonson said that William Shakespeare “was not of an age, but for all time.” Nevertheless, it is evident from the empirical literature that he definitely wrote his plays for his own age and time. The thematic material often reflected current events, particularly the most dramatic of these events (Simonton, 1986b). And it is difficult to imagine an event more striking than military conflict. So, in line with expectation, Shakespeare’s thematic content tended to be responsive to wartime circumstances. In the first place, whenever a foreign power attacked his native land, England, his plays had a tendency to discuss political expansion, empire, and conquest as the goals of war. In addition, various revolts and rebellions would stimulate discussion of life’s conflicts. Even conspiracies against the monarch left an imprint on the Bard’s plays. Nor was Shakespeare unique in his responsiveness to international and intranational war. Comparable results appear to hold for the ancient Athenian playwrights Aeschylus, Sophocles, Euripides, and Aristophanes (Simonton, 1983).

Content analytical studies have found that international war affects the content of poetry as well. Poems written during wartime are noticeably different from those written in peacetime. For instance, one investigation scrutinized how concomitant war casualties related to the content of French and English poetry (Martindale, 1975). When wartime deaths and injured intensified, poets were more likely to treat moral imperatives (more often using such words as should, right, and virtue in their poems) but were less likely to invoke the theme of chaos (less often using such words as wild, crowd, and ruin). Just as intriguing, war intensity was positively associated with content indicative of rationality, restraint, and control. All in all, wartime poems place more emphasis on maintaining the moral order in the face of evil and chaos.

Finally, it is worth mentioning a curious relation between war and a very specialized literary theme – that of Don Juan. Although Don Juan legend originated in Spain, he proved to be such a popular character that various versions appear in other national literature as well. In any given literary tradition, the frequency of Don Juan versions correlates positively with how much that nation was engaged in warfare (Winter 1973). What makes this association most interesting is that the Don Juan theme can be linked with the need for power. The character’s sexual conquests are indicative of interpersonal dominance, just as war is an instrument of international dominance. Because war itself is also connected with power motivation, enhanced interest in the Don Juan reflects a national shift toward the need for power. Significantly, this literary theme peaks about a decade after the peak in warfare.

Philosophy

Philosophers are apparently no more immune from war’s influence than are the composers and writers. This impact was demonstrated in an extensive generational time-series analysis of over two thousand thinkers from the ancient Greeks to modern Western civilization (Simonton, 1976). A team of experts first rated the thinkers on the stances on several key intellectual issues. These issues included the fundamental nature of reality (ontology), the basis for human knowledge (epistemology), and the criteria for good and evil (ethics). These thinkers were then tabulated into separate generational time series for each philosophical position, yielding a measure of fluctuations in major intellectual ideas. Because war was hypothesized to function as a developmental influence, a time-lagged analysis was used. That is, the number of philosophers in generation g was related to the amount of war in generation $g - 1$, or 20 years earlier. Significant relations were found for both intranational and international war.

1. Intranational war, and especially substantial civil disturbances, has a polarizing impact on intellectual debate, again after a one generation delay. To be specific, 20 years after such collective violence philosophers tend to advocate (a) empiricism (all knowledge comes through the senses), rationalism (all knowledge comes through reason), and mysticism (all knowledge comes through revelation); (b) materialism (matter is the fundamental basis of reality) and idealism (spirit or mind is the fundamental basis); (c) eternalism (reality is unchanging) and temporalism (reality is in constant flux), (d) realism (abstract ideas really exist) and nominalism (abstract ideas are but names in our language); (e) singularism (the individual is of primary importance) and universalism (the society is primary); (f) determinism (everything is caused) and indeterminism (humans have free will); and (g) the ethics of happiness (good and evil based on pleasure), the ethics of principles (good and evil decided by universal rules), and the ethnics of love (good and evil guided by compassion). It is as if the political polarization that causes intranational war in generation $g - 1$ induces ideological polarization in generation g .
2. In contrast, international war has a far more selective effect, and a negative one, discouraging the emergence of certain beliefs. In particular, one generation after major international warfare philosophers are less likely to advocate empiricism, temporalism, nominalism, singularism, and the ethics of happiness. In other words, thinkers are less prone to argue that knowledge comes through the senses, that reality is constantly changing, that abstract ideas are but names, that individuals have priority over society, and that moral decisions should be based on what causes pleasure and pain. Evidently, these particular stances are not favored during wartime conditions, perhaps because these beliefs might be antithetical to the extreme patriotism and self-sacrifice required for the war effort. So, future philosophers who grow up under such circumstances are less likely to espouse these beliefs as adults.

As will be shown later in this article, sometimes the causal relations can be reversed, certain ideologies increasing war after a generational delay.

Science

It was shown earlier that international war has an immediate impact on the annual output of discoveries and inventions. In the previous section, however, it was seen that war can exert a long-term influence on philosophical creativity. Given that scientific creativity is partially dependent on the prevailing philosophy of a given age, the latter result implies that war might have enduring consequences for science as well. For instance, it seems reasonable to infer that scientific ideas might become less empirical and materialistic in line with similar changes in philosophy. Regrettably, no research has investigated this possibility. Even so, one empirical study has indicated a possible immediate connection between war and science in psychology. The [Peter Suedfeld \(1985\)](#) content analyzed the presidential addresses delivered by 85 Presidents of the American Psychological Association. The speeches were specifically scored for integrative complexity, a measure of how many distinct perspectives a person considers and the extent to which these perspectives are successfully integrated. Some of these presidential addresses were delivered during peacetime, whereas others were delivered during the Spanish-American War, one of the two World Wars, the Korean War, or the Vietnam War. Cognition was much more complex in those addresses given during times of peace. What makes this correlation even more interesting is that the distinguished psychologists who score high on integrative complexity tended to practice a different kind of psychology than those who score low. The former are more prone to view psychology as a human science, and thus be more humanistic or clinical in their orientation, whereas the latter are more likely to see psychology as a natural science, and therefore be more behavioristic or experimental in orientation. By implication, the presence or absence of war seems associative with qualitative differences in psychological science.

Effects of Creativity on War

It has been assumed so far that creativity is somewhat at the mercy of politics. War either lowers the amount of creativity or else modifies the nature of the creativity that does appear. Despite that assumption, sometimes researchers have found evidence for influences going in the opposite direction. These consequences operate at two levels, the aggregate and the individual.

At the aggregate level, there is some tentative evidence that certain ideologies tend to encourage the development of the militaristic ideas that lead to war ([Simonton, 1976](#)). This evidence came from a generational time-series analysis that compared the relation between prevailing philosophical beliefs at generation g and the level of international war at generation $g + 1$. When civilization becomes dominated by sceptical and materialistic ideologies, then warfare was likely to increase about 20 years later. This time-lagged relation held from the ancient Greeks to the beginning of the 20th century. Because scepticism and materialism may undermine ethical values, and even lead to a high degree of political cynicism, the youth exposed to these ideas may be more disposed to become adults who are far more willing to see war as a viable means to attain a desired end. This possibility may bring to mind the ideal leader according to *The Prince* written in 1513 by Niccolò Machiavelli: The end justifies the means.

At the individual level, it becomes useful to return to the concept of integrative complexity. As noted earlier, integrative complexity tends to decline during wartime, and it tends to be associated with the type of psychology displayed by a President of the American Psychological Association. But the variable's connections with both war and creativity are even more complicated than so far discussed. To start with, integrative complexity is positively correlated with creative problem solving. Creative people are able to look at a problem from multiple perspectives and, when necessary, discover a solution that integrates those alternative points of view. Thus, Albert Einstein examined a problem in physics from the standpoint of both Newtonian mechanics and Maxwellian equations, saw the contradiction between the two, and resolved the conflict by deriving his special theory of relativity. By the same token, high integrative complexity is associated with effective leadership, especially in the area of decision making and problem solving. For instance, the more successful US presidents score higher in integrative complexity than do the less successful. In the case of war, integrative complexity is involved in two ways.

First, research has shown that international crises are more likely to result in international war when the political leaders facing crisis score low in integrative complexity (e.g., [Suedfeld and Tetlock, 1977](#)). If the goal is to resolve the conflict, then leaders must be able to examine the issues from multiple perspectives, and then find a satisfactory integration of those perspectives. The various parties to the crisis can then identify a resolution that allows the tensions to be reduced peacefully. If the leaders score low in integrative complexity, they can only see the crisis from one point of view (their own), and reconciliation becomes impossible. War then becomes the only answer. In a sense, when a crisis results in war, it is a sign that the world's leaders failed to exhibit sufficient creativity.

Second, once war breaks out, military leadership becomes more critical than political leadership. To a very large extent, the nations with the superior commanders will have an edge over their opponents in the conflict. Research indicates that those military leaders who score highest in integrative complexity are most likely to emerge victorious in battle ([Suedfeld et al., 1986](#)). To be effective, a commander must be able to view the military situation not only from his point of view but also from that of the enemy commander. By inspecting the situation from all possible perspectives, the commander can determine the most probable consequence of a given tactical decision. In short, the leader can "second guess" his opponent. Of course, integrative complexity is probably an asset with respect to strategy, and not just tactics. Hence, it enhances the national capacity to win the war, not just the battles making up the war. In short, military success demands a certain amount of creativity.

These two points taken together point to an ironic conclusion: It may take some amount of creativity to avoid war, and also a certain amount of creativity to win a war once it has begun.

Conclusion

Creativity is an enormously important phenomenon. Modern culture is largely the accumulation of creative acts since the beginning of civilization. War is also a tremendously significant phenomenon. Few political events affect so many people so dramatically, and often permanently. The history of humanity is very much a narrative of its major wars, battles, and conquests. Putting these two obvious facts together might lead to the conclusion that the relation between creativity and war would be a frequent subject of research. Yet that is far from the case. Direct empirical studies of their association are actually quite rare. To be sure, this article has reviewed a rich inventory of empirical results. However, close examination of the literature shows that the diverse findings are scattered and disconnected. Too often one investigator will approach the topic in ignorance of past research already published on the subject. As a consequence, frequently researchers end up duplicating results rather than building on the prior results of their predecessors.

Another liability has to do the lack of a strong theoretical foundation for almost all published inquiries. The typical investigation tends to be exploratory, war constituting just one of numerous situational factors thrown into a set of independent variables. Complicating the problem all the more, investigators do not always define war in the same way, thereby obtaining divergent results. Furthermore, as mentioned earlier, researchers have often employed rather diverse methodological approaches, such as contrary units of analyses. Such contrasts can also affect the outcomes.

In light of these unfortunate limitations in the research, it is hoped that future investigators will adopt a more systematic approach to this crucial question. In particular, subsequent investigations should adopt a stronger theoretical framework that more firmly guides the critical methodological choices. Until then, those curious about the relation between creativity and war must be contented with a heterogeneous collection of piecemeal observations.

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Writers[☆]

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Introduction

This entry will provide an overview of the research techniques used to study eminent creative writers as well as the results of the research. These writers were deemed eminent through their body of work rather than any single publication. Their creativity was evident in the exceptional quality of their work which clearly differentiated them from their peers.

Writers have been studied using a variety of techniques including studies of biographies, interviews and assessment of writers, case studies, evaluations of the writing process, psychobiographies and the systems approach. The results of this research will be summarized regarding early family history, education, mental illness, suicide and lifespan. Research related to the creative process includes motivation and personality factors as well as work habits. Finally, writing used in institutionalized settings as an aid for recovery will be discussed.

Research Techniques

Studies of Biographies

Researchers seek generalizations about eminent writers by compiling statistical data using biographies. They compare this data with information about other creative achievers and the general population, looking for any significant differences. Conclusions from these types of studies may apply to writers as a group, but do not indicate the characteristics of any individual writer.

[☆] *Change History:* 2019. Changed title from Writing and Creativity to Writers. Changed abstract, added Introduction, updated research and cut section regarding non-eminent writers and healing.

This article is an update of S.R. Pritzker, Writing and Creativity, Editor(s): Mark A. Runco, Steven R. Pritzker, Encyclopedia of Creativity (Second Edition), Academic Press, 2011, Pages 525–532.

Interviews and Assessments of Writers

Researchers interview eminent writers about their work and in some cases give them psychological evaluations and tests. The majority of these studies evaluate the characteristics and mental health of writers. Other researchers conduct semi-structured interviews focusing on a writer's background, career path, motivation, work habits, internal processes, and personal life. When multiple interviews are conducted, connections that indicate similarities and differences between the subjects are usually offered. Researchers have also used archival interviews in books, magazines, and newspapers to analyze prominent writers.

Case Studies

Researchers prepare case studies about individual writers by studying their life and work. The results presented in this entry will not emphasize individual case studies since they are usually complex and vary widely depending on the training, methodology, and perspective of the author. Study of collaborative creative writing is just beginning. A combination of interviewing, observation, and evaluation of changes in the work offer insights into the decision-making process as well as the personal dynamics and leadership factors which may encourage or discourage creativity. Case studies may provide valuable insights but the results can't be generalized.

The Writing Process

The mechanics of the writing process including preparation, writing and rewriting have been examined from different angles. Genetic criticism defined two ways to study the writing process – program writing and process writing (See [Alamargot and Lebrave, 2010](#)). Program writing focuses on an individual creative writer's actual work from preliminary sketches through completion looking for a pattern. Process writing looks at the inspiration and then the revisions. Many authors alternate between structuring and working in a more flexible format.

Neuroscientific studies examining the writing process in real time are relatively rare but one study indicated significant differences in cerebral activity between professionally trained and inexperienced writers ([Kessler et al., 2014](#)).

The Psychobiography

Freud expressed admiration for creative writers who he said were far in advance of everyday people, because they draw on sources which have not yet opened in science. Freud wrote about the life of DaVinci which served as the prototype for the psychobiography, a format in which key psychological elements in an author's life, which theoretically influenced their work, are presented. Psychobiographies are almost always made without the subject's participation. Critics of this methodology complain there is a great deal of unproven speculation involved, as analyses are not based on experiments or independent evidence. The psychoanalytic method may reduce life to psychological processes, ignoring social, economic, or political forces. More recent researchers in creativity, such as Howard Gardner, concluded that Freud's characterizations apply to noncreative as well as creative individuals and thus do not distinguish the effective artist or scientist from the banal one. Others believe that though Freud's work was not scientifically accurate, his method might provide an imaginative look into the mystery of creativity.

The literature includes many articles by psychological practitioners who analyzed the content of a writer's work including themes and specific characters in relation to a specific personal characteristic of the author, such as psychopathology, addiction, disease, or wish fulfillment. A few psychoanalysts and psychologists, most notably Albert Rothenberg, worked with writer-clients who allowed them to write about their creative process using aspects of their therapy.

The Systems Approach

The evolving systems approach [see [EVOLVING SYSTEMS APPROACH](#)] examines the creative person's life in five contexts, including: total body of work, the milieu in which they worked, their family and personal life, and the sociohistorical period in which they lived. This approach has been used in studying writers by examining their creative process based on different drafts of their work and their own recollections.

Results of the Research

Early Family History

Large scale biographical studies consistently indicate that successful writers came from more turbulent family backgrounds and suffered more emotional instability when they were children. [Goertzel et al. \(1978\)](#) studied the lives of 717 eminent personalities who had two or more biographies written about them since 1962. The Goertzels compared 92 literary figures with other eminent personalities who lived in the 20th century. They found writers were:

1. More likely to be only children (26% vs. 17% overall).
2. Tended to be voracious readers (77% vs. 48%).
3. Disliked school (52% vs. 33%).
4. Came from homes described as very unhappy (67% vs. 44%).
5. Had more alcoholic parents (one or both) (11% vs. 7%).

Jane Piirto (2002) reviewed the lives of 160 writers using survey questionnaires, essays, published interviews, and reference books. She found family trauma was a theme including alcoholism, parental suicide, weak or absent fathers, being orphaned, poverty, physical and sexual abuse, divorce, and mental illness. A few writers had placid childhoods but they represented a small percentage. Numerous writers and researchers have commented that writers may often find a way in their work to create a new world for themselves.

Arnold Ludwig (1995) examined the lives of 1004 eminent people who had a biography reviewed in *The New York Times Book Review* between 1960 and 1990. Included in the total were 180 fiction writers, 64 nonfiction writers, and 53 poets. He found that writers were more likely to have fathers, mothers, and siblings with identifiable pathological problems. In a separate study, Ludwig found that significantly more women writers came from families with mothers or fathers with psychopathology and that more of these writers were physically or sexually abused as children.

Kay Jamison (1993) described the genealogies of a number of writers who had close bi-polar relatives which included Robert Burns, Charles Dickens, Ralph Waldo Emerson, Ernest Hemingway, Henry and William James, William Faulkner, and F. Scott Fitzgerald. This may have been a creative advantage since research conducted by Ruth Richards and Dennis Kinney indicated that an individual with a close relative who is bipolar is more likely to be creative. (See Bipolar Mood Disorders).

Education

Not surprisingly, the majority of children who became writers were voracious readers who escaped into the world of books and in some cases movies. Freud wrote about the relationship between childhood fantasy and writing: "Might we not say that every child at play behaves like a creative writer, in that he creates a world of his own, or, rather, rearranges the things of his world in a new way which pleases him?" (1908: 131–132).

Exceptional curiosity was a common trait along with an early interest in writing. Young writers such as Eugene Ionesco, Sylvia Plath, and Pearl Buck displayed promise and received encouragement from teachers for their writing skills. However others such as Academy Award winning screenwriters William Goldman and Tom Schulman did not display any particular talent for writing until later in life. Many creative writers were bored or just felt they did not fit in. High school dropouts include famous writers such as Herman Melville, Mark Twain, Ring Lardner, Will Rogers, and Noel Coward.

However the romantic notion of the dropout writer who lives in poverty until discovered is changing as the path for many successful writers, especially novelists, includes an undergraduate and graduate school degree, often from top-flight schools that may allow them to teach as their writing career evolves. Programs such as the Iowa Writers Workshop and UC Irvine and top film schools such as USC and UCLA are training successful writers.

Mental Illness

Writers, along with other creative artists, have been subject to the speculation that genius and madness are linked. This association can be traced back to Plato's colorful description of poets' 'divine madness' as well as Aristotle's claim that all creative people were touched with melancholia. Biographical studies support the notion that fiction writers and poets had much higher rates of psychopathology than other creative professions and the general population.

For example, Arnold Ludwig (1995) reported that 28% of his total sample of writers had a mental disorder in their lifetime including a striking 87% of poets, 77% of fiction writers, and 72% of nonfiction writers. Women writers may be even more at risk. Ludwig (1994) interviewed and compared 59 female writers matched with a control group. He found female writers had higher rates of depression (59% vs. 9%), alcoholism (20% vs. 5%), drug abuse (17% vs. 5%), panic disorder (22% vs. 2%), generalized anxiety (14% vs. 5%), and eating disorders (12% vs. apparently none). Women writers, like men, suffered more bipolar illness and depression, but they also had had more problems with alcohol, were more suicidal, and had a lower life expectancy than other eminent professionals.

Andreason conducted structured interviews with 30 faculty members at the Iowa workshop over a period of 15 years. She performed a psychiatric diagnosis of both writers and their relatives, comparing them with a matched control group. She concluded that 24 of the 30 writers (80%) suffered from an affective disorder compared to nine (30%) of the control sample. She diagnosed 13 writers with a bipolar disorder and 11 with a major depressive disorder. In fact, two writers committed suicide while the study was taking place. Using the family history method, she also diagnosed the writers as having many more first-degree relatives with affective disorders and creative ability. Andreason recognized the limitations of her study, including the fact that she was cognizant of the writers and the controls. Also, writers might have more awareness of affective illness both in themselves and in their relatives. She also commented that the degree of illness diagnosed might be exaggerated by the broad definition of bipolar illness in the DSM. Andreason was the sole interviewer and this particular group of writers may have turned to teaching because of depression.

Kay Jamison (1993) interviewed 47 British prize-winning writers and artists with a mean age of 53.2 years, asking them if they had been treated for mental illness. She discovered that 38% had been treated for affective illness at some point, 23.4% had taken antidepressants, and 6.4% had been diagnosed as manic-depressive (all poets). She compared this with 'normal lifetime rates' of 5% for depression and 1% for manic-depression.

The most comprehensive face to face study of professional writers was analyzed by Frank Barron (1961), who, with other psychologists, interviewed and psychologically tested 30 professional writers nominated by the faculty of the University of California at Berkeley. Also included in this study were 26 'successful and productive' student writers and nonwriters. Barron tested for the presence of psychopathology by administering the Minnesota Multiphasic Personality Inventory. He found the most eminent writers scored high on scales measuring schizoid, depressive, hysterical, and psychopathic tendencies and in terms of femininity of interest pattern. However, these writers also registered higher scores on ego strength, so Barron concluded that while they suffered psychological turmoil, they also possessed more resources to deal with it. He felt this conclusion was reinforced by their social behavior since they presented themselves as clearly effective people with pride and distinctiveness while sometimes showing pain, protest, distance, and withdrawal, as well as being very emotional. Barron's study warrants replication with a contemporary group of writers because his conclusions might vary with subjects who lived in a different time frame.

There is also evidence that more successful writers who win Nobel Prizes and Pulitzer Prizes may be more likely to have mental illness. James Kaufman found similar results in two historiometric studies of 986 20th century writers and 889 writers who lived from 1600–2000. He concluded that: "In both studies, both types of prize-winners were more likely to suffer from mental illness than nonwinners. In addition, Nobel Prize winners were more likely to suffer from alcoholism ... and experience a personal tragedy" (2000–2001: 305). A partial list of writers thought to have serious mental illness problems are listed in Table 1. An interesting point in looking at this incredible group of talented writers is that they had illustrious careers despite having to deal with mental illness.

Ludwig suggested that writers demonstrate more psychopathology because writing and poetry rely on a 'personal vision' which is based on an internal subjective experience as opposed to science where more stability may be required to do work that has 'predictability, replicability, reliability, and testability.' The arts tolerate eccentric and irrational behavior much more readily than other professions. In fact, the creative writer's uniqueness is his or her stock in trade, and it takes a strong, independent personality to go one's own way. The characteristics that support this kind of abnormality are similar to the traits that characterize psychotic behavior. For example, James Joyce's unique thought processes influenced the language in his work which became his creative hallmark.

There is also the distinct possibility that the characteristics of mental illness can be a detriment or benefit to creativity, depending on the individual case. For example, creative writers and poets may be far more sensitive to their emotions. Freud felt writers use fantasy to satisfy these needs. This anticipates other researchers who concluded the difference that composes what has been called the thin line between genius and madness is control. This point of view acknowledges that creative writers may at times exhibit traits of mental illness, but argues they are essentially healthy because they can make critical judgments about their thoughts and work that would be impossible if they were truly pathological. Other researchers take the opposite position that psychotic thinking is an essential ingredient in creativity.

A third possibility accepts both psychopathology and creativity as ingredients which may vary along a continuum. At times creativity and schizophrenia may be inextricably linked together in varying degrees. Examples include the poet Holderlin, who was diagnosed as schizophrenic; Strindberg, who had a schizoaffective disorder; and writers who displayed a schizoid or schizothymic temperament, including Baudelaire, Kafka, and Beckett. It may be the schizoid or schizotypal propensities and world view which gave these writers' creative contribution its uniqueness.

Hypomanic traits have been cited as a positive force giving some writers energy, concentration, and confidence which enhanced their work. Depression inspired a small percentage of writers to work harder, perhaps attempting to escape their pain. Other writers such as Edgar Allan Poe used their dark moods as a source for some of their best work.

However, most writers with mental illness paid a heavy price in both their personal and their professional lives. Most reports by psychiatrists, psychologists, and writers indicate that being in the throes of mental illness is not a good place to work. Richard Berlin argued that: "Severe depression interferes with motivation, energy, drive realistic self-assessment, and pleasure" (2008: 4). Sylvia Plath said "When you are insane, you are busy being insane all the time ... When I was crazy, that's all I was" (Flaherty as cited in Berlin, 2008: 4). Ezra Pound, Virginia Woolf and Sylvia Plath spent parts of their lives in mental institutions. Depression and manic-depression hampered the ability of many eminent writers, including Joseph Conrad, Leo Tolstoy, John Ruskin, and Ernest Hemingway.

Summing up, there are impressive indications that eminent writers as a group suffer more problems than other eminent creators or the general population. Despite the robustness of the statistics, they must be considered cautiously. Diagnoses have often been made posthumously using loose and inconsistent diagnostic criteria. In many cases the validity of a diagnosis of mental illness, alcoholism, or suicide cannot be verified. In addition, solid statistical evidence of the extent of mental illness, alcoholism, and suicide in the general population is still far from precise. Finally, it is possible writers with dramatic lives and early deaths are more likely to become eminent and have biographies written about them.

Table 1 Writers thought to have mental illness

James Barrie (playwright/fiction)
Charles Baudelaire (poetry/nonfiction)
Honore de Balzac (fiction)
William Blake (poetry/fiction/nonfiction)
Elizabeth Barrett Browning (poetry)
Robert Browning (poetry/playwright)
Truman Capote (fiction/nonfiction/playwright)
Samuel Taylor Coleridge (poetry/nonfiction/playwright)
Joseph Conrad (fiction/playwright/nonfiction)
Hart Crane (poetry/playwright/nonfiction)
Charles Dickens (fiction/playwright/nonfiction)
F. Scott Fitzgerald (fiction/nonfiction)
Ian Fleming (fiction)
Robert Frost (poetry)
Nikolai Gogol (fiction/playwright)
Graham Greene (fiction/nonfiction/screenplays/playwright)
Ernest Hemingway (fiction/nonfiction)
Franz Kafka (fiction/nonfiction)
Jack London (fiction)
James Joyce (fiction)
Robert Lowell (poetry/playwright)
Guy du Maupassant (fiction/nonfiction/poetry)
John Stuart Mill (nonfiction)
Frank O'Connor (fiction/nonfiction/playwright)
Sylvia Plath (poetry/fiction)
Edgar Allan Poe (poetry/fiction/playwright)
Ezra Pound (poetry/nonfiction)
Arthur Rimbaud (poetry)
William Saroyan (fiction)
Friedrich Schiller (poetry/drama/nonfiction)
Arthur Schopenhauer (nonfiction)
Delmore Schwartz (poetry/fiction/nonfiction)
Anne Sexton (poetry/fiction/nonfiction)
Percy Bysshe Shelley (poetry/fiction/nonfiction/playwright)
Christopher Smart (poetry/nonfiction/librettos)
August Strindberg (playwright/fiction/poetry)
Jonathan Swift (fiction/nonfiction/poetry)
Torquato Tasso (poetry/playwright/nonfiction)
Alfred Tennyson (poetry/playwright)
Leo Tolstoy (fiction/nonfiction/playwright)
Virginia Woolf (fiction/nonfiction)

Note: Many authors are classified as having mental illness automatically if they demonstrated heavy use of alcohol or drugs.
Sources: Ludwig, Magill, Prentky, Simonton, and others.

Suicide

Individuals who have problems with traumatic childhood loss, mental illness, alcoholism, and drug abuse are more likely to commit suicide, so it is not surprising the suicide rate among writers is higher than average. Difficulty with their writing is a factor contributing to writers' suicides. A partial list of writers who are believed to have committed suicide is in [Table 2](#).

In [Ludwig's \(1995\)](#) study, eminent people in general were more likely to commit suicide (4.4%) than the general population, which had an estimated rate of 1.0% to 1.4%. However, 20% of the poets were considered suicides. Fiction writers had an average rate of suicides while nonfiction writers were below average. Ludwig proposed that emotional problems often interfered with creative productivity, but actually improved performance for 16% of eminent creative people by increasing productivity, overcoming writing blocks, and generating new ideas or better performances. The Goertzel found that 11% of writers committed suicide compared to 5% of their total sample.

Poets are more at risk than other groups and female poets represent the highest percentage of writers who commit suicide. [Kaufman and Baer \(2002\)](#) pointed out that female poets are introspective and the expressive nature and style of their poetry does not provide the health benefits of other kinds of writing. They cited other salient reasons including the implicit expectations of illness by the gatekeepers who evaluate poetry, the higher evidence of mental illness in female poets and the fact that poets tend to peak at an earlier age when bipolar illness and other mood disorders are more likely to strike. (See Poetry)

Table 2 Some writers thought to have committed suicide

Ryunosuke Akutagawa (fiction)
John Berryman (poetry/nonfiction/fiction)
Truman Capote (fiction/nonfiction/playwright)
Thomas Chatterton (poetry/playwright)
Hart Crane (poetry/playwright/nonfiction)
Maxim Gorky (fiction)
Spalding Gray (screenwriter/performer)
Tom Heggen (fiction/playwright)
Ernest Hemingway (nonfiction/fiction)
Yasunari Kawabata (fiction)
Heinrich von Kleist (fiction/playwright)
Jack London (fiction/nonfiction/playwright)
Yukio Mishima (fiction/nonfiction/playwright)
Cesare Pavese (fiction/poetry/nonfiction)
Sylvia Plath (poetry/fiction)
Anne Sexton (poetry)
Sara Teasdale (poetry)
Hunter S. Thompson (journalist)
Marina Tsvetayeva (poetry/playwright/nonfiction)
Virginia Woolf (fiction/nonfiction)
David Foster Wallace (fiction/nonfiction)
Stefan Zweig (fiction)

Sources: Hendrickson, Ludwig, Magill, Prentky, Simonton, Lester, and others.

Substance Abuse

Alcoholism has been a problem for many accomplished writers, including Nobel prize-winning authors Sinclair Lewis, Eugene O'Neill, and William Faulkner. The generation of American expatriate writers in post-First World War Paris that included Ernest Hemingway and F. Scott Fitzgerald glamorized and romanticized drinking, making it a more sophisticated and respectable behavior. A partial list of alcoholic writers includes James Agee, Charles Bukowski, Truman Capote, Raymond Chandler, John Cheever, Dashiell Hammet, O. Henry, James Joyce, Jack Kerouac, Norman Mailer, Dorothy Parker, Edgar Allen Poe, John Steinbeck, Robert Louis Stevenson, William Styron, Dylan Thomas, Tennessee Williams, and Thomas Wolfe. Writers who used their drinking experiences for major works include Eugene O'Neill (*The Iceman Cometh*), William Burroughs (*Naked Lunch*), and Malcolm Lowry (*Under the Volcano*). Jack London wrote an alcoholic memoir (*John Barleycorn: Alcoholic Memoirs*) and Charles Bukowski's semi-autobiographical fiction and poetry were filled with his alcoholic experiences.

Albert Rothenberg reviewed biographical and autobiographical data of writers known for their use of alcohol. He found very few did their actual writing or their thinking about writing, while under the influence of alcohol. In Ludwig's study of the biographies of 34 well known heavy-drinking writers, artists, and composer/performers, he found that alcohol negatively affected the work of 75%, especially as the drinking continued. Long-term drinking has physiological effects which directly hinder the concentration required of creative individuals. However, Ludwig believed that drinking actually benefited 9% of the subjects. Writers such as Hemingway, O. Henry, Raymond Chandler, and John O'Hara claimed that drinking *improved* the quality of their writing. Many writers recognized they could not write well while they were drinking. F. Scott Fitzgerald and Ring Lardner said they went on the wagon when they worked.

Koski-Jannes (1985) reviewed 60 interviews with prominent Finnish writers who started writing between the 1920s and 1950s. Only 32 writers commented on their use of alcohol while they wrote since this was not a primary question in the interviews. Writers who used alcohol occasionally saw it as an aid in getting started or a stimulus when they were tired. Duplicating results of studies in England and the United States, poets reported more alcohol use than other types of writers. The most heavy use for all writers occurred between writing projects.

Immediately after a project was finished, writers reported they felt "empty, depressed and dissatisfied with themselves." They considered going out and drinking as a way to loosen up and relax, make social contacts with other writers, and generate new ideas. Writers also said they used alcohol to dissociate themselves from common concerns, and to facilitate the writing process. Koski-Jannes suggested that among the reasons writers use alcohol frequently are that the job is insecure, highly valued but poorly paid (at least in Finland), and the profession is subject to conflicting expectation from the reading public, critics and the writer her or herself (lose publicity pressures). As actual work it is unstable, lonely and at times emotionally highly demanding. Because of the marginality of this profession the identity of the writer is continually at stake (1985: 131).

These comments sum up the hazards of the job mentioned by a number of researchers. However, it does not explain why some writers respond to these pressures by drinking heavily while other writers drink in moderation or abstain. A few researchers have

attempted to determine if alcohol facilitates creative writing under laboratory conditions. There were indications that alcohol significantly increased the number of words produced, which confirms anecdotal accounts of writers who found alcohol an aid in writing. However, these studies did not examine professional writers, so any determination of the quality of thinking under actual working conditions remains unknown.

Often the term 'depression' is mentioned when it comes to writers who drink, which indicates that it may be used as a form of self-medication. If, in fact, more writers tend to be alcoholics than the general population, it is still not clear if the job makes writers depressed or depressed people are more likely to choose writing as a profession. Since most alcoholic writers were drinking before they started writing, perhaps professional writing was attractive because it allowed the individual the freedom to continue drinking. It is also possible that writing, like alcohol, serves as a way to escape negative feelings.

A questionnaire given to writers on this topic indicated that writers experience positive emotions significantly more often than negative emotions when writing. Furthermore, during the actual writing process, positive emotions tended to intensify, whereas negative emotions resisted change. Ludwig's analysis indicated that poets and fiction writers trail only musicians and theatrical performers when it comes to drug use and abuse. Coleridge allegedly wrote about the palace of Kublai Khan while on opium; Keats tried the drug and described his experience. Elizabeth Barret Browning, Louisa May Alcott, and Jean Cocteau used opium. Aldous Huxley made no secret of his fondness for mescaline, which he wrote about in *The Doors of Perception*. Phillip K. Dick was addicted to amphetamines. Stephen King wrote in 2000 about being hooked on alcohol, cocaine, and prescription medicines.

It's impossible to accurately measure the level of drug use because, aside from the question of legality, some writers might be afraid their reputations would suffer if they publicly admitted they used drugs. As times change, writers' use of alcohol and drugs may change. Recent studies challenge the popular notion that creatively successful individuals lead excessive life styles. A survey of 22 writers, 27 artists, 12 musicians, and 25 controls about use of cocaine, marijuana, alcohol, etc. found no significant difference in the use of most substances between groups. However, a high rate of heavy use (23%), a small sample, and an even smaller control group preclude any definitive conclusions.

Life Span

Researchers concluded the stresses caused by being a professional writer result in a measurably lower life expectancy. A comparison of the age of death of 160 writers with that of 80 members of nine other creative occupations found that writers died at an average age of 61.7 years, which was 8.3 years less than composers and painters. Several hypotheses have been put forward to explain the cause of writers dying at an earlier age:

1. The theory that poets produce their major works at a younger age so they could die at a younger age and still be considered eminent in their field.
2. The differential-resources hypotheses, which suggests the lower financial rewards and standard of living in the literary arts results in a shorter life expectancy.
3. The stimulation-deprivation explanation which posits the meager financial rewards and sensory stimulation found in writing leads to risk-taking behavior elsewhere.

A study by [Vincent Cassandro \(1998\)](#) found creative writers living an average of 62 years, which was three to seven years less than contemporaries in other disciplines. Scientists and inventors lived the longest. Cassandro concluded evidence supported the first two hypotheses, but not the third. He also made the logical link between a writer's psychopathology and a lower life expectancy. This is exemplified by the fact that poets are definitely more at risk than fiction and nonfiction writers. In 2003, [Kaufman \(2003\)](#) found this higher risk for poets cut across cultures in a study that looked at 2000 American, Chinese, Turkish, and Eastern European writers. This is not surprising in view of the fact that poets suffer more mental illness, substance abuse problems and suicide.

Cassandro's study offered significant evidence that the more writers diversified, the longer they lived. However, the sample was of subjects born no later than 1800 and thus might not generalize to the 21st century. Similarly, the findings might not apply to less eminent creative people or for writers in different fields. In 2009, [Steven Pritzker and David McGarva \(2010\)](#) found that Academy Award winning screenwriters lived to an average age of 72 although it has slipped below 70 since the 1970s. More in-depth research verifying the actual economic status of the creators studied, the actual cause of death, and the interaction of psychopathology upon these variables could help build knowledge in this area.

Writers Creative Process

Motivation and Personality

Why do writers write? It has been proposed that mental disturbances contribute to a state of 'psychological unease' which generates creative tension that is relieved by constant work, and that creators who do not have emotional problems are able to internally generate this unease. Others have theorized that writing may satisfy a biological drive, a search for meaning, or a means to fame and fortune. Barron theorized that writers are constantly creating a universe of meaning. This need to find meaning in life may be based on childhoods in which writers felt isolated and unhappy. This theory could explain why so many writers find the act of writing difficult. Creating a world that reveals lasting truths is bound to be frustrating as the writer searches for the right words.

However, despite all the pressures and frustrations, many writers have found great satisfaction in their work. For some, writing provides an escape from the pressures of life, offering a place where he or she is in control. Positive aspects frequently mentioned include the pleasure in discovering more about themselves and making new intellectual and emotional connections, feeling they have a real purpose, communicating with others and sharing their reactions when they find something which represents some underlying 'truth' about life, and the enjoyment of working with words. Some individuals found a long-sought sense of identity when they became writers.

Two motivations to write which have not been explored in depth are fame and fortune. Research in experimental settings has indicated that the relationship between intrinsic motivation and extrinsic motivation varies according to circumstances. It is probable that in the real world fantasies of celebrity and wealth helped some writers keep working through the lean times. Economic necessity motivated some writers. Dostoyevsky produced some of his best work when he needed money.

Many novelists and playwrights in the twentieth Century took lucrative offers from movie studios. Some including Fitzgerald and Faulkner felt that they 'sold out' to Hollywood where they had no control over their work. Usually they wrote bitterly about the experience.

Fame, once achieved, has been a part of the career fabric for many authors who enjoyed the attention. Ernest Hemingway's macho image helped sell his work while giving him ego gratification. However, fame also creates tremendous pressure. Expectations can become so high that writers become blocked. Writing became especially competitive in the 1920s when writing a great novel was not enough – it had to be a best seller.

Today's authors are expected to sell themselves on social media, tv and radio interviews and appear at book signings so they can generate enough publicity to become a 'name brand.' The alcohol and drug problems many writers experience may be exacerbated by the drive for success, prestige, fame, and money, and the burden put on the creative self.

Work Habits

Creative writing may be sparked in many ways (e.g., a glimpse of a person or imagining a scene) and inevitably encompasses autobiographical elements. Once the subject is chosen, some prolific writers such as Stephan King can produce work with incredible speed. Isaac Asimov reported he would write at the 90 words a minute he could type, and stated he wrote most nonfiction books in 70 hours. However, many writers struggle finding the form which fulfills their vision.

Writers' work habits are as individual and idiosyncratic as their work. Some professional writers discipline themselves by treating writing as a nine to five job. Others may give themselves a daily quota of words or pages to fill. There are writers who like to isolate themselves while others enjoy working in cafes. Some write a specific number of pages every day while others procrastinate until they are faced with a deadline and then put in marathon hours.

Most writing decisions offer a number of choices, so often writers develop different drafts of stories and scenes, learning as they rewrite what works for them and what must be changed. During this evolutionary process their original perceptions may radically shift – a minor character may grow into a central figure, or the theme of a story may go in a completely different direction.

Thus the creative process in writing is usually not linear, but rather a series of steps that are repeated over and over as refinements are made. Many writers will look for feedback from one or more trusted sources while the work is in progress. Some writers may complete hundreds of pages and decide the idea does not work at all. The most constructive work is done in a state of total concentration which almost seems effortless at the time, referred to as 'flow.' The author must remain open to the message whispered by the unconscious, while at the same time maintaining critical judgment.

Writer's Block

A common complaint among both amateur and professional writers is the inability to work known as writer's block. This experience is intimately connected to the uncertainty and tension inherent in facing a blank page every day. Factors contributing to writer's block are self-doubt, perfectionism, procrastination, unrealistic expectations, and fear of failure. Some strategies suggested for countering blocks include writing anything (even about being blocked), setting up a regular time and place to write, isolating oneself from distractions, stopping writing when there is some momentum left so the work can be continued the following day, going to another project for a while, and using positive self-talk. The fact that even blocked writers may eventually produce important work is exemplified by Karl Marx, who spent 18 years writing the first volume of *Das Kapital*.

Collaborative Writing

The act of writing is usually an internal process so it has been difficult to make independent observations of elements that encourage or discourage creativity. Research about collaborative writing in television script writing, indicates that specific elements encourage creativity, including the willingness to take risks and providing a safe atmosphere where members of the group build upon each other's' ideas while they are free to argue (Pritzker, 1998). Negatives include unresolved emotional conflict between the writer and supervisors, differences in communication styles, settling quickly on a predictable story, and the tendency of executives to demand massive rewrites generating fear of change and fatigue.

Creative Writing in Institutions

Creative writing is used as a tool to help prisoners and patients dealing with mental illness. Cognitive researchers concluded that creative writing takes tremendous effort and requires a great deal of attention; thus for some troubled people it helps center the thinking process and provides insight into problems. William Styron and Art Buchwald wrote about their deep depression as a catharsis and with the hope the public would understand more about the debilitating nature of their illness. Political prisoners such as Thomas Paine, John Bunyan, and Daniel Defoe used their time in jail to write books that furthered their own cause. Prisoners committed for other crimes who wrote notable works while in jail include O. Henry, William Penn, Marco Polo, Oscar Wilde, Eldredge Cleaver, and Malcolm X. The Marquis de Sade completed the circuit since he began his writing career in prison and continued it in a mental institution.

Conclusions

Work on writing and creativity has consistently indicated that many writers suffer problems with psychopathology, alcoholism, and drug abuse. The next step is to go beyond the interesting and logical theories proposed for this connection and develop verifiable causal explanations.

Information on the life expectancy of writers needs further investigation. If writing inherently contains occupational hazards, then therapists and creative writing teachers can develop a proactive stance to help some of their clients understand and cope with the stress of the job and deal with their personal demons.

Much of the research has concentrated on eminent writers. Learning more about professional writers who are more 'ordinary' can widen the knowledge base and possibly lead to training which can encourage creativity.

While a great deal of attention has been paid to dysfunctional writers, the healthy writer (if one exists) is barely represented in the literature. It might prove worthwhile to look closely at the lives of writers with less dramatic histories since they may serve as positive models other writers may emulate.

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Relevant Websites

- <http://www.pw.org/magazine> – Poets & Writers Magazine.
- <http://www.writersdigest.com/GetCreative/> – Writer's Digest.

Zeitgeist[☆]

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Introduction

In Shakespeare's *Twelfth Night* a character utters the famous lines "Some are born great, some achieve greatness, and others have greatness thrust upon them." The first option would seem to apply to royalty and aristocrats, and the second to the great geniuses who make history [see Genius and Greatness]. The third possibility suggests that sometimes greatness is not a matter of being the right person but rather can be attributed to being at the right place at the right time. Even creators as outstanding as René Descartes, William Shakespeare, Leonardo da Vinci, and Ludwig van Beethoven are nothing more than products of larger sociocultural circumstances beyond their control. In a sense, geniuses are mere epiphenomena – effects rather than true causal agents. That is, geniuses are pawns of the Zeitgeist, a German word that literally means "time spirit," or "spirit of the times." The word "Zeit" has the same origins as the English root "tide" still seen in such words as eventide, Christmastide, and Shrovetide. And the German word "Geist" has the same source as the English "ghost," which came from the Old English word for breadth or spirit. The term Zeitgeist is closely linked with Ortgeist, another German word that signifies "spirit of the place." In practice, the two terms can be used interchangeably. The near equivalence ensues from the fact that the "spirit" is invariably confined to a particular time and place. For example, when we speak of the Age of Pericles we are simultaneously talking about a particular place (Athens) at a specific time (about 445–429 BCE) – the Athenian Golden Age. There was no Periclean Age in Rome, and even less in Africa, Asia, and the Americas. Hence, throughout this article Zeitgeist will be used in the inclusive sense to encompass the Ortgeist as well.

As the preceding example illustrates, the Zeitgeist is often associated with eponyms – names of persons that became labels for eras or periods in history. Other examples include the Elizabethan Age in England or the Age of Louis XIV in France. Even so, sometimes the Zeitgeist is identified by more impersonal names, such as Renaissance Italy or the British Industrial Revolution. The latter usage is more consistent with the tenor of the Zeitgeist theory of history. The expression Victorian Age seems to imply that the British Queen Victoria had something to do with the making of the age. Yet Zeitgeist advocates, such as Leo Tolstoy in his *War and Peace*, are emphatic that eponyms have no causal significance. On the contrary, the Queen was the pawn rather than agent of her age. Her sole contribution was to live long enough to provide an all-encompassing label for a whole period in history.

[☆] *Change History:* May 2019. Dean Simonton updated the text throughout the article.

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In its extreme form, Zeitgeist theory becomes equivalent to sociocultural determinism and reductionism. All individual behaviors, including creativity, are determined by social and cultural variables. As such, the individual is reduced to a set of norms, roles, and other factors that exist outside the person, and prior to the person. However, it is possible to acknowledge the impact of the Zeitgeist without adopting such an extremist stance. The Zeitgeist then provides a set of variables that join psychological and biological factors in the making of the creative genius.

To understand better how the Zeitgeist affects creativity, we must first recognize that the Zeitgeist assumes two forms: the internal and the external.

Internal Zeitgeist

At the level of everyday creative behavior, creativity can often be generic. Thus, a person who writes an imaginative American haiku might also produce a creative collage. In contrast, high-level creativity tends to be much more domain specific. It is as unlikely that T. S. Elliot could have painted *Guernica* as it is improbable that Pablo Picasso could have penned "The Waste Land." Accordingly, to some extent the Zeitgeist must also be domain specific. The Zeitgeist associated with Newtonian or "Classical" physics will have a far greater influence on the creativity of physicists than it will on the creativity of sculptors. Likewise, the Zeitgeist connected with Socialist Realism had a bigger impact on the arts than on mathematics.

One illustration of this domain-specific contingency is seen in the phenomenon of role-model availability. It has been long observed that creative genius is not randomly distributed across time and place. Instead, geniuses tend to congregate into temporally and geographically restricted clusters – the best of which are often called "Golden Ages." Moreover, these clusters take time to emerge and time to dissipate. Typically, a given civilization might begin with a few progenitor or precursor geniuses, and in successive generations the creativity attains a climax, after which activity trails off in a series of epigones or inferior successors. Hence, although the Golden Age of Greek philosophy is clearly defined by the apex represented by Socrates, Plato, and Aristotle, this peak was preceded by pre-Socratic thinkers and succeeded by post-Aristotelian thinkers of lesser merit – such as Democritus and Theophrastus, respectively.

Detailed generational time-series analyses [see War] have identified the basis for this clustering (Simonton and Ting, 2010). Each generation of creators tends to build upon the work of the previous generation. As Plato builds upon Socrates, so does Aristotle build upon Plato. It is extremely rare for a creator to appear *de novo*, sans predecessors, and whenever that happens the creativity tends to be inferior to what occurs during the climax. In a nutshell, creative development is contingent on the availability of role models during the creator's childhood and adolescence, when the individual is acquiring creative potential. And, obviously, that role-model availability is most effective if its domain specific. Albert Einstein's creative potential is going to be fostered more by senior physicists than by older architects. When Newton famously said that he saw farther than the rest by standing on the shoulders of giants, he certainly meant figures like Kepler and Galileo.

Unfortunately, once the Golden Age attains the acme, subsequent generations tend to exhibit a progressive decline. The reasons for this decadence are complex, and probably in part domain specific. Alfred Kroeber (1944), the cultural anthropologist, attributed the decline to "pattern exhaustion." After everything has been said within the constraints of a given cultural milieu, or Zeitgeist, there is no place to go next but down. Once painting has culminated in perfect photographic realism, then where can painters go next? They either must scramble to paint ever more exotic objects or they must find some alternative stylistic goal. Another disabling influence may be imitation. Too many potential creative geniuses of the post-climax generations may be tempted to imitate the masters of the Golden Age rather than risk developing their own unique voice. And ultimately such imitation may be antithetical to genius, as argued by the philosopher Immanuel Kant. At the end of World War II the Dutch minor painter Han van Meegeren was revealed to have painted imitation Vermeers that art experts had actually certified as authentic. But rather than being hailed as an artistic genius he was condemned as a mere forger of fakes. It is one thing to create one's own distinctive style from scratch and quite another to ape the style of others.

Whatever the details, role-model availability exemplifies one way that the Zeitgeist operates to influence creativity in every generation and in every creative domain. In part, the Zeitgeist in any give period consists of the inventory of recent creative achievements that can inspire subsequent creativity. Below we turn to more specific processes that are confined to particular domains. We first look at the sciences, and then turn to the arts.

Scientific Creativity

Thomas Kuhn's, 1970 *The Structure of Scientific Revolutions* presented a highly influential internalist theory of scientific discovery. The theory applies to paradigmatic disciplines in which practitioners exhibit a high theoretical and methodological consensus. An example would be physics which in the 17th and 18th centuries was largely governed by the Newtonian or "classical" paradigm. Scientists operating within a paradigm are engaged in "normal" science, a puzzle-solving enterprise that aspires to extend the paradigm's explanatory scope and precision. However, over time "anomalies" begin to accumulate. These are results that do not fit within the accepted paradigm. On occasion, these anomalous findings can be assimilated. For example, Newtonian celestial mechanics managed to explain a perturbation in the orbit of the planet Uranus by predicting the existence of a new planet. When that planet, Neptune, was observed, it became a triumphal confirmation of the paradigm. Other times the anomalies cannot be easily assimilated without introducing post hoc alternations that undermine faith in the paradigm. For instance, an anomaly in

the orbit of Mercury resisted all attempts at a Newtonian explanation (including the prediction of an unknown planet). If enough of these anomalies accumulate the discipline may enter a “crisis” state that can only be resolved by the introduction of a new paradigm [See Paradigm Shifts]. These paradigm shifts are promoted by practitioners of “revolutionary” science. An example was Albert Einstein’s introduction of relativity theory in the early 20th century. And the cycle continues. The key feature of this process is that the Zeitgeist is defined by the discipline (viz. the paradigm) rather than being determined by sociocultural factors outside the discipline, such as war [see War].

Interestingly, normal scientists can be psychologically distinguished from revolutionary scientists. To illustrate, the latter are more prone to be laterborns (Sulloway, 2014) and to exhibit higher rates and intensities of mental illness (Ko and Kim, 2008). So the paradigmatic Zeitgeist has psychological as well as disciplinary consequences.

Artistic Creativity

Like Kuhn, Colin Martindale (1990) was fascinated with disciplinary change, but in his case the focus was on stylistic change in the arts, especially in literature. Just as the paradigmatic sciences show paradigm shifts, so do the arts display stylistic shifts. A Romantic poet does not write the same kind of poetry as a Neo-Classical poet. To explain these changes, Martindale proposed an evolutionary theory. The theory begins by assuming that all creators are operating with a given set of aesthetic conventions that define a particular style. However, creative individuals are also under pressure to maintain the “arousal potential” of their products. This impetus means that they have to generate ever more novel and surprising works within the given style. To attain this end, creators have to increasingly rely on “primary process” imagery (or primordial thinking). Yet after a few generations this cognitive regression goes so far that the stylistic constraints begin to break down. The style then becomes exhausted in a manner similar to Kroeber’s concept of pattern exhaustion. The only salvation is to introduce a new style. Because the style itself is novel, arousal potential can be maintained without much regression into primary process. And the cycle then repeats.

Martindale (1990) has conducted a large number of empirical investigations that provide support for his evolutionary theory. Most notably he has used computerized content analyses to show that over the history of any given literary tradition both primary process imagery and stylistic change tend to exhibit inverse oscillations. When a new style is introduced primary process declines. At the same time, Martindale has shown that these stylistic changes are internal to a given art form. That is, such changes are affected very little by external events.

External Zeitgeist

The German philosopher Georg Wilhelm Friedrich Hegel argued that history was driven by a dialectic process involving pure ideas. A given ideational thesis would yield an antithesis which in its turn would produce a synthesis – and the latter would be a new thesis for the continuation of the cycle. Political, social, and economic systems were nothing more than manifestations of that intellectual history. In contrast, Karl Marx famously “turned Hegel on his head” by arguing that the dialectic was materialistic rather than idealistic. In particular, the economic system, as defined by the means of production, underwent a dialectic process that drove history through the successive stages of slavery, feudalism, capitalism, and finally communism. In the Marxian view, the world of ideas – including both artistic and scientific creativity – was but the external consequence of the resulting economic conditions. Feudal art or science would have to be different than capitalist art or science because they reflected contrary materialistic circumstances. Needless to say, this reflectionist or externalist perspective is antithetical to the internalist positions discussed previously. It leads to a sociocultural determinism in which both paradigms and styles are epiphenomenal rather than causal. When artists in a communist state turn to “Socialist Realism” it is not because the previous style had exhausted itself but rather because the new style better complies with the new economic milieu.

Although the extreme position is probably overstated, it remains true that creativity is not completely immune from the external Zeitgeist. The latter impact is evident in empirical research on how political, economic, and sociocultural circumstances affect both the quantitative and qualitative aspects of creativity observed at a particular point in time.

Quantitative Aspects

The impact of the external Zeitgeist on the quantity of creativity can be assessed two main ways.

On the one hand, we can use generational time-series analysis to count the number of creators active in each time period, where the latter is most often taken as a 20-year interval (Simonton, 1984). Specific political, social, economic, and cultural events or conditions can then be assessed in the same intervals. The relation between these two time series then provides information about the connection between the two measures. However, often the association between the two series is lagged rather than simultaneous. More precisely, the number of creators in generation g might be a function of the external Zeitgeist in generation $g - 1$. This lagged function would imply that the magnitude of creativity is contingent on the developmental experiences that future creators have in childhood and adolescence. As an illustration, for many domains of creativity the number of creators at generation g is a negative function of the level of political anarchy at generation $g - 1$, where the latter is gauged by political assassinations, military revolts, palace coups d’état, and the like (Simonton, 1975). Another feature of the political Zeitgeist that may have a lagged effect is political fragmentation (i.e., the number of independent or sovereign states into which a given civilization is divided). Growing up

under such conditions may enhance creative development, possibly via increased bilingualism and multiculturalism (but see Refs. [Simonton and Ting, 2010](#)). In the same vein, civilizations tend to become more creative a generation or two after they have been exposed to influences from alien civilizations or cultures ([Simonton, 1997, 2018](#)). In a nutshell, the aggregate level of creativity is prone to increase after an influx of sociocultural and linguistic heterogeneity.

On the other hand, we can use a smaller unit of time, such as a single year, to tabulate the number of creative products in a given temporal interval. This approach is clearly more refined. Shorter units of analysis allows for the possibility that the external Zeitgeist might have more finely-tuned effects. If certain extrinsic conditions can fluctuate rapidly from one year to the next, then their consequences will be overlooked when using larger aggregates. A prime example is the impact of war [see War]. Although war has no effect on the number of creators counted into 20-year periods, this dramatic condition does have a repercussion at the level of yearly tabulations. When war is followed by peace creators seem to make up for lost time, and thus create the works that were set aside during the military conflict. So the adverse impact is obliterated when the analysis expands from years to generations.

All in all, it is apparent that the quantitative implications of the external Zeitgeist are substantial. They can determine both the number of creators that appear in a given generation and the number of creative products that appear in a given year.

Qualitative Aspects

The qualitative impact of the Zeitgeist is perhaps even more interesting than the quantitative. During a specific period in history, the number of creators in Chinese civilization might equal the number of creators in European civilization, and yet the products generated by these two sets of creators might be radically different in qualitative characteristics. In the case of painting, for example, Chinese painters might be creating highly idealistic landscapes that exist only in the artist's mind while European painters are creating highly realistic portraits of actual people.

Fortunately, some empirical research does indeed show that external conditions affect qualitative features of creative products. To illustrate, consider the following set of findings: (a) compositions in the classical repertoire exhibit distinct stylistic aspects depending on whether they were composed during peacetime or wartime conditions ([Simonton, 1986](#)); (b) specific features of Greek ceramic paintings reflect the degree to which economic and political power was concentrated in a small proportion of people ([Dressler and Robbins, 1975](#)); and (c) the thematic material presented in plays corresponds to a noticeable degree with concurrent political events ([Simonton, 2004](#)). These effects are all contemporaneous, whereas other external influences require a substantial delay. An especially interesting lagged effect is the polarizing effect of civil disturbances ([Simonton, 1976](#)). One generation after a region has seen an increase in nationalistic revolts or political rebellions there tends to be a divergence in the positions advocated by notable philosophers. That is, thinkers who grew up under such circumstances have a higher likelihood of becoming proponents of diametrically opposed viewpoints. For instance, there will appear both extreme materialists and extreme idealists, extreme empiricists and extreme rationalists, and so forth.

To be sure, the correspondences are far from perfect. Many creators will be sufficiently individualistic that their work will not accurately reflect the external Zeitgeist. Even so, enough creators in any given generation conform enough that their products taken as a whole will represent their times.

Mixed Zeitgeist

Naturally, the foregoing represented extreme positions. The Zeitgeist is not exclusively external or internal. Rather, the two guises of the Zeitgeist operate together. Creativity in most domains is the joint function of both the internal and external Zeitgeist. That conclusion can be illustrated using both artistic and scientific creativity.

Artistic Creativity

Creativity in the arts is contingent on both types of Zeitgeist. This contingency is apparent in the empirical research on the thematic material in the compositions that make up the classical repertoire. On the one hand, it is clear that themes or melodies undergo stylistic changes, just as in literary creativity. The music of the Baroque period is identifiably different from the music of the Classical or Romanic periods. Moreover, the evidence suggests that these stylistic shifts are partly driven by the same kind of processes that [Martindale \(1990\)](#) discusses in his evolutionary theory. For example, because of the constant pressure on composers to be original, their melodies tend to become more novel, surprising, and unpredictable over the course of their careers. This longitudinal trend then induces a historical trend: Melodic originality tends to increase over time ([Kozbelt and Meredith, 2010](#)). On the other hand, the research also shows that the nature of the melodic material also depends on the larger sociocultural conditions. For instance, melodies become more unpredictable and variable when a composition is created under wartime circumstances – particularly if the composer is active near the war zone ([Cerulo, 1984](#)). There is even an Ortgeist effect. Provincial composers who were born and raised far from the music centers of their day tend to create less strikingly original themes relative to cosmopolitan composers who emerged from one of the centers of music activity ([Simonton, 1986](#)).

The foregoing illustration concerns qualitative effects operating on single creative products. Yet the internal and external Zeitgeist can also exert joint quantitative effects on individual creators. This twofold influence is apparent in research on the Japanese literary

tradition (Simonton, 1992). One peculiarity of this literature is the conspicuous presence of female writers, particularly during the Golden Age represented by the Heian period. As a case in point, Murasaki Shikibu, who is credited with writing the world's first true novel, has something of the status of William Shakespeare in English literature. Even so, it is also clear that the appearance of outstanding female literary creators fluctuated throughout Japan's history, and in some periods they would disappear altogether. It turns out that both internal and external factors are involved. In the first instance, female literary greats are most likely to emerge in those generations that feature male literary greats. Stated differently, only when Japanese culture favored literature as a form of creative expression will women have a high probability of making a contribution. In contrast, the appearance of female writers is uniquely discouraged by such extraneous conditions as Confucianist ideology. Because Confucianism promotes a hierarchical system that places women in an inferior position, it harms female creativity but not male creativity. Indeed, the dominance of Confucian ideas inhibits female achievements in other domains besides literature.

Scientific Creativity

From time to time two or more scientists will make the same discovery independently of each other. Well-known examples include the calculus by Newton and Leibniz, the conservation of energy by Mayer, Helmholtz, and Joule, the theory of evolution by natural selection by Darwin and Wallace, and the plague bacillus by Yersin and Kitasato. Likewise, it sometimes happens that two or more inventors will independently create the same invention. Instances include the ophthalmoscope by Babbage, Helmholtz, and Anagnostakis, photography by Daguerre and Talbot, and incandescent lamp carbon filament by Swan and Edison. Such events have been termed multiple discoveries or inventions, or just plain multiples [see Multiple Discovery]. What renders these occasions especially dramatic is that sometimes the multiples are virtually simultaneous. In effect, Alexander Bell and Elisha Gray showed up at the US Patent Office with their respective inventions of the telephone on the exact same day! Furthermore, many more than two rival claimants may be involved. The dynamo may have had as many as nine independent inventors. Nor are these multiples rare. Examples run into the hundreds.

This phenomenon has often been taken as prime evidence for sociocultural determinism, the strongest form of Zeitgeist theory (Lamb and Easton, 1984). Although research shows that this inference is unjustified – multiples are largely chance events – it remains true that they illustrate the influence of the Zeitgeist. The Zeitgeist provides the necessary but not sufficient conditions for a given discovery or invention. Calculus presupposes an analytic geometry, which in its turn depends on the prior advent of algebra, the latter being contingent on the previous existence of arithmetic. In this case, this sequence of dependencies illustrates the internal Zeitgeist within the discipline of mathematics. Yet on occasion the internal Zeitgeist will be joined by the external Zeitgeist, creating a mixed effect. A particularly dramatic example is the atomic bomb. The internal Zeitgeist in nuclear physics had already demonstrated the theoretical possibility of such a weapon. But it took the external Zeitgeist, in the form of World War II, for physicists to receive the tremendous resources required to convert this possibility into a reality. Although the atomic bomb was not a multiple, it might have become so had not the defeat of Germany terminated its own program.

Individual Versus Society

Too often the Zeitgeist is evoked to minimize the importance of the creative individual, even the creative genius. This derogation is especially commonplace in many discussions of multiples. If both Newton and Leibniz came up with the calculus, then the calculus must have been “in the air” just ripe for the picking. However, this implication does not follow from the evidence. Nor do the other findings mentioned earlier in this article serve to dethrone the individual creator. The creative person remains for three main reasons.

First, two individuals can be born in the same place and time – identical Ortgeist and Zeitgeist – but still exhibit greatly differing degrees of creativity. One might become a universally hailed genius while the other becomes an obscure also-ran. Conversely, two persons of comparable achievements might be born in very different times and places. Consider the four scientists credited with discovering the Mendelian laws of genetics: Mendel, born 1822 in Heinzendorf bei Odrau, Austria (now the Czech Republic); Hugo de Vries, born 1848 in Haarlem, Netherlands; Carl Correns, born 1864 in Munich, Germany; and Erich von Tschermak-Seysenegg, born 1871 in Vienna, Austria.

Second, even when exact contemporaries and compatriots exhibit equal magnitudes of creativity, that creativity may appear in totally distinct domains of achievement. Where one becomes a Nobel laureate in physics, the other might become a laureate in literature. Any large metropolitan area in any given year will give birth to dozens if not hundreds of creative individuals who make their respective contributions to radically different domains.

Third, the level and the type of creativity are both determined by numerous variables that are inherent in the singular creator. Indeed, these non-Zeitgeist influences explain the previous two observations. The most obvious influence is genetic inheritance, which will affect both the type and magnitude of creativity. In addition, different creators will grow up under distinct family backgrounds. In fact, even if two creative individuals came from the same household, they might differ because of their birth order. As an example, the Tolman family in West Newton, Massachusetts, had two sons born 5 years apart. The oldest, Richard, became a famous mathematical physicist, whereas the youngest, Edward, became a famous psychologist. Beyond the family there are various other developmental influences, such as education, mentors and role models, friends and colleagues, work environments, etc. This huge inventory of developmental experiences serves to individualize each creator. Consequently, each creator becomes something more than just a pliable pawn of the Zeitgeist.

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Glossary

Beginner's mind The many possibilities regarding meditation in the mind of a beginning mediator.

Enlightenment A final blessed state marked by the absence of desire or suffering.

Koan A paradoxical question that cannot be answered using ordinary logic.

Mushin The state of 'no mind' or 'no ego' in which true emptiness is achieved.

Nirvana An advanced state of enlightenment in which desire, frustration, and ignorance are dissipated so absolute silence and stillness reign.

Samadhi The state in which consciousness is stopped and the individual is no longer aware of time, space, and causation.

Satori The moment of enlightenment when one sees into one's own nature.

Zazen Zen sitting meditation.

Zen A Japanese sect of Mahayana Buddhism that aims at enlightenment by direct intuition through meditation.

Brief History of Zen Buddhism

Prince Gautama was born near the border of Nepal and India in approximately the 6th century BC. His wealthy father gave him every luxury and kept him protected within the palace walls. When the prince finally left his sheltered life, he was very upset when he encountered sickness, old age, and death. He met a holy man who seemed happy despite the problems that surrounded him, so the prince decided he would seek his own liberation. He became a holy man, wandering the country without finding peace. Finally he vowed to sit on a straw mat under a bodhi tree until he found an answer. He sat there for six days. On the morning of the seventh day, he awakened to the morning star and became enlightened. Prince Gautama became known as The Buddha.

Tathagata developed the Four Noble Truths, which emphasized that life's suffering was engendered by selfish craving that could be overcome through following the eightfold path of right understanding, purpose, speech, conduct, livelihood, effort, alertness, and concentration. The detachment of a solitary life led to liberation. The ultimate goal was achieving Nirvana, which represented a state of undisturbed peace.

[☆] *Change History*: 2019. Revised abstract, updated research and added small edits. Added key words, new references and a website.

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The founder of Zen Buddhism was The Bodhidharma who was the 28th patriarch of Indian Buddhism. He arrived in China about AD 520. The Bodhidharma meditated facing a wall for nine years before becoming a teacher. His teaching was based on the principles of Mahayana Buddhism, which emphasized helping others and concrete experience. His disciples continued teaching in China.

Zen became recognized as a separate branch of Buddhism about AD 700 during the time of the patriarch Huineng. Huineng stressed the concept of emptiness, which minimized the importance of the individual ego in a world where everything and everybody are connected and constantly changing.

Zen Tenets

This section reviews basic tenets of Buddhism including suspicion of language, meditation, the use of koans and enlightenment. The Bodhidharma called for 'no dependence on words and letters' but 'direct pointing to the real person, seeing into one's nature and attainment of Buddhahood.' Buddha stated that all humans are inherently enlightened; however, there is a need to practice in order to remove the obstacles to experiencing satori. Satori is reached through the study of koans, meditation, and living a purposeful life. 'Chop wood, drink water' – concentrate on what is necessary at this moment. It takes most people a great deal of training to calm what is called in India 'monkey mind,' the constant chatter of thoughts, for even a few moments. Zazen is a form of meditation in which concentration on breathing and calming the mind helps the practitioner lose awareness of the body. The goal is to reach a state where time, space, and causation, as the framework of consciousness, drop away.

Koans are a unique method of teaching. The student is assigned a koan – for example, 'What is the meaning of Mu?' The individual repeats the koan over and over during meditation until suddenly its truth is revealed.

There are rare times when enlightenment happens very quickly but most people reaching enlightenment can be a long, challenging path. Philip Kapleau (1965) suggested that the three essential qualities necessary for enlightenment include (1) strong faith, (2) a strong doubt based on the imperfect state of the individual and the world compared to the idealistic image, and (3) strong determination to dispel this doubt with the whole force of one's energy and will.

Enlightened individuals are encouraged to participate in life. D. T. Suzuki stated that "the object of Zen training consists in making us realize that Zen is our daily experience and that it is not something put in from the outside." The enlightened individual interacts with everybody in a different way because the desire for ego gratification and material things no longer dominate the individual's thinking. Success and failure, happiness and unhappiness all become an accepted part of life.

Zen and Creativity in China and Japan

By AD 800 Zen was widely practiced in China. Zen's influence on culture was relatively minor. It contributed to Chinese philosophy in the Sung dynasty and a form of 13th century asymmetrical painting called *one corner* that was eventually exported to Japan. This inspired the *thrifty brush* style of Japanese painting that reflected the simplicity of Zen experience. Zen gardens and calligraphy also originated in China, but it was in Japan where Zen had the most impact on culture. Zen monasteries became the primary source of learning and art for the upper classes in Japan. Creativity was inherent in the teaching practiced by the Zen masters who used improvisational methods specifically tailored to the individual student.

The model of discipline and concentration required in Zen influenced other aspects of life. Training was often done by a master teacher similar to a roshi or Zen teacher. The idea of reaching mushin, a state of 'no mind,' penetrated the arts in Japan and stimulated creativity in many areas. Mushin represents the highest state of consciousness with no thoughts or judgments clouding the mind. Students practiced calligraphy, painting, or archery until the routine requirements – the moving of the pen or brush or the firing of the bow – could be accomplished automatically without thought. This training took many years because conscious control was not surrendered easily. Students without self-consciousness could completely absorb themselves in the moment, allowing intuition rather than intellect to control their process. When the mind was clear with no duality in the way, true human nature could take over and the artist knew where the brush was supposed to go. Zen influenced the following professions:

Architecture and Design

Many great Zen temples began as imperial palaces and castles. They are noteworthy because they reflect and respect the unique beauty of the gardens that surround them.

The Japanese tea room, which originated in the 15th century, is an excellent example of how Zen deeply influenced many aspects of Japanese culture. The tea ceremony is a ritual designed as a diversion from the everyday world. Each tea room is built specifically for the individual tea master.

The ceremony begins with a walk through a garden where stepping stones form an asymmetrical path. The walk through a tea garden is intended to foster recollection and inner peace. The tea room's construction is deliberately delicate, consisting of bamboo supports and thatched roofs. The interior is strikingly simple with a fire pit, tatami mats, and a hanging scroll or some other object of art. Tea ceramics are a Japanese art form. Each item is carefully chosen to be part of a group. After the special tea is brewed and drank, the tea master and guests may discuss each implement or the beauty of nature. Ordinary business matters are left outside in this

special world. The simplicity of tearoom decor has influenced the design of functional things, including kitchen implements, floor mats, textiles, and common bowls and cups.

Calligraphy

Calligraphy originated in China in the 3rd century AD. The ink (sumi) was mixed using an inkstand to grind an ink block made of lampblack and glue. Sometimes poetry was created spontaneously, which contributed to the development of haiku.

The first Zen calligrapher was Huang Ting-chien (1045–1105) who became enlightened and recognized this changed the quality of his writing. Dogen Kigen (1200–1253), a legendary Zen master, founded the Soto sect. He was a highly skilled calligrapher who emphasized the importance of meditation.

Art

Ashikaga monochrome ink painting began as a natural extension of calligraphy. The black ink can be mixed in various shades that suggest the perception of color. As stated by T. Hoover, the purpose of Zen painting is to penetrate beyond the perceptions of the rational mind, to show nature's essence. The artist paints the enlightenment of the moment, and therefore has no time to labor over each stroke. Absolute concentration is crucial because no retouching can be done. The artist never pauses to evaluate his work. The ink flows in a dramatic flurry of strokes producing a sense of rhythm, movement, form, and the artist's vision of life's inner music.

This type of painting began in the Sung dynasty in China as a rebellion against conventional art similar to the abstract expressionist movement. Ch'an monks threw ink and rubbed it in by hand or using their hair. Three types of schools emerged: Zenkiga emphasized Zen parables, insight, and practice. Chin'z specialized in portraits of well-known Zen teachers.

A third school focused on landscape painting with a very specific set of rules including which items were usually present (mountains, trees, rocks, etc.). Each painting was divided into three tiers that illustrated the scene from different perspectives. These landscapes pioneered concepts that became important in other Zen art including the symbolic use of empty space and emphasis on rocks and trees, which eventually became significant metaphors.

Japanese monks who traveled in China brought Zen painting home in the 13th century. Sesshu Toyo (1414–81) reinvented the form so that it reflected Zen precepts in its veneration of nature's beauty. He inspired a number of other artists who worked for the next 150 years.

Gardening

Zen gardens were also inspired by Chinese models created during the Sung dynasty. The use of rocks, trees, sand, and water were replications of Ashikaga ink landscapes. The idea of depicting a garden as a three-dimensional painting inspired the development of perspective and abstraction approximately the same time as Ucello (1397–1495) was doing similar work with painting in Italy.

The Zen garden was designed, like a painting, for viewing with the hope the emotional reaction of the viewer would inspire greater awareness. Excellent examples from the 13th and 14th centuries are in Kyoto. War and poverty in the 15th century inspired the creation of stark stone gardens called *kare sansu*. These monochromatic gardens were specifically designed for meditation. They anticipated several art techniques by centuries including the abstract expressionist 'symbolic arrangement of mass and space.'

Haiku

Haiku is a tightly structured poetry format that requires the use of exactly 17 syllables. The poems are written in time to the seasons and often encompass themes about nature. Created in the 14th century, haiku was popularized by the Zen monk Basho (1643–94). Haikus represent Zen thinking in absolute absorption in the moment, offering a direct clear unmistakable experience without reference to anything else.

With every gust of wind,
The butterfly changes its place
On the willow

The best haikus are those which arise from the tension between the rigidity of the form and the depth of the poetic feeling.

Other Arts

The No drama, developed in the 13th century, used masks, dances and poetry to explore emotional experience. However, because there is no story and very little movement, most untrained Westerners have difficulty appreciating the plays. Like other Zen arts, the purpose is to inspire a profound emotional response. The Japanese puppet theater was also impacted by Zen.

Zen was used to train the samurai in swordsmanship and archery. The Zen archer practiced breathing until it was second nature and the arrow could be released without thought. Intense concentration allowed Zen archers to attain phenomenal accuracy. A Zen mind-set helped warriors overcome fear and respond automatically and unconsciously with deadly accuracy during battles. In 1281, the samurai defeated Kubla Khan's army of more than 100 000 men. Zen also influenced the creation and training in martial arts such as kung fu, aikido, and judo.

Psychotherapy

Dr Shoma Morita developed Morita therapy in Japan in 1917. Noda (2009) noted that: "Drawing from Zen Buddhism, Morita therapy essentially helps people accept their destiny. In addition, the way people and traditional healers coexist reveals uniquely Japanese ambiguity and wisdom for accepting life as it is" (p. 167). The original method was focused on behavior change in clients with a variety of anxieties.

Naikan (which means inner looking in Japanese) takes place at a number of centers around Japan where patients stay for a week which is similar to the structure of Buddhist retreats. Ryback et al. (2001) stated:

"The Naikan-sha (client) is invited to meditate from 6 in the morning until 9 in the evening (meal and bathroom breaks excepted) in a comfortably seated position focusing on problematic interactions with significant others, taken in life-long chronological order – parents, siblings, spouse, and so on" (p.133).

Specific themes focusing on relationships are selected and then short face-to-face meetings occur every hour or two. This format of brief highly focused meetings is what a Zen roshi (teacher) might do. A recent study indicated that a combination of Morita and Naikan therapy was effective in helping patients with general anxiety.

Hakoniwa is a therapy used in Japan which resembles Sandplay in the West. Zen gardens are designed to invoke both a sense of beauty and peaceful spirituality. During the session a miniature Zen garden with various figurines and objects is available. Clients build gardens that "may describe their internal world, and together with other methods, may begin to formulate a narrative of themselves" (Merlino, 2010, p. 1).

Renku is group therapy that directly uses the creative process in a format reminiscent of haiku. Participants each write a short verse: "The challenge of each individual is to render the previous stanza as deeply understood as if one were in the person of the author of that stanza, with both conscious as well as unconscious spheres of knowing" (Ryback et al., 2001, p. 132). The goal is to increase empathy and create a sense of group harmony.

Zen and Creativity in the West

After the Second World War II, teachers from Japan moved to the United States and Europe establishing Zen centers in major cities and mountain retreats.

Beat Zen Writing and Music

Beat Zen was embraced in the 1950s by some writers and musicians who felt they were rebelling against American conformity. Alan Ginsberg's poems reached a wide audience, while Jack Kerouac wrote popular semiautobiographical novels such as *The Dharma Bums*. Drugs, especially marijuana, were identified with beat Zen enthusiasts. Alan Watts felt Kerouac wrongly extended 'anything goes' at the existential level to his writing and personal life. He argued that the social responsibility inherent in Zen Buddhism was forgotten in Beat Zen.

John Cage developed a form of 'music' that used multiple tape recorders and wrote a piano recital where the pianist did not play a note, but a page turner still turned the pages. Meditation music labeled Zen has become so popular there are channels available on the streaming services.

Books about Zen and using Zen multiplied with training advice and application for a number of fields including education, writing, career planning, guitar, and even stand-up comedy. Peter Matthiessen, a Zen practitioner for many years wrote about his search for inner peace in *The Snow Leopard*, (1978) which won the National Book Award. As vegetarian diets increased in popularity, some Zen cookbooks cracked the marketplace.

Physiology

Meditation, mental exercises (koans), and skill training have been sources of interest for researchers in neurology and biology. Alpha biofeedback training may have originated with electroencephalogram (EEG) monitoring of Zen and Yoga practitioners

who claimed that meditation may create a unique form of consciousness. Researchers found that zazen, when practiced by Monks, created slower breathing patterns and more muscle relaxation.

In 2009, Alberto Chiesa summarized key points after reviewing the literature including the finding that increased theta activity in advanced meditators helped relax various regions of the brain as well as reducing stress and lowering blood pressure. He added that: "Zen meditation practice could protect from cognitive decline usually associated with age and enhance antioxidant activity" (p. 585).

There may be similarities between meditation and the flow state in terms of total absorption. A small study of musicians indicated that even a brief period of meditating may help reduce performance anxiety. However, there is still a great deal of research needed to understand the potential for positive interaction between Zen meditation and the arts.

Psychology

Zen has been advocated by some psychologists as a valuable tool that can complement traditional therapy. Modern interpretations of this include relaxation exercises, hypnosis, biofeedback, and openness to experience.

Carl Jung admired Zen, but felt the states achieved sometimes had delusional elements. Like most Western psychologists, Jung believed in the concept of the self, which could never really know the collective unconscious. This viewpoint contrasted sharply with Buddhist practice, in which the experience of satori awakened and absorbed the unknown self into a world beyond human consciousness.

Some theorists criticized the use of Zen in therapy, suggesting that Zen's fixation on enlightenment could trigger psychological problems. Another criticism was that Morita therapy was inappropriate for patients in the West because of its cultural dependence.

Other psychologists proposed that Zen could help reduce the ego, expand consciousness, and promote self-integration. The argument was made that the sudden enlightenment and gradual training in Zen practice were comparable with 'insight' and 'working through' in psychology. The concept of personal growth inherent in Zen is a cornerstone of psychotherapy, especially notable in the work of Abraham Maslow and Carl Rogers. The psychotherapist was compared to a Zen martial arts teacher in terms of developing specific teaching techniques and strategies for each client. Albert Ellis suggested that Zen could be integrated with rational-emotive therapy.

Morita therapy, Naiken, and Hakoniwa were all adapted in the West with some success. A number of American psychologists wrote books and articles with their own recommendation for combining Zen and psychology.

Creativity Research

Investigation into creativity confirms the inherent worth of aspects of Zen training. Some researchers proposed that there is a similarity between solving koans and the creative problem-solving model of preparation, incubation, illumination, and evaluation. After preparation and incubation, a solution to a koan or a problem comes suddenly and unexpectedly. Satori is similar to the 'Aha' moment in creativity. Then the viability of the solution must be evaluated.

Research indicated creativity may be facilitated in sitting meditation by freeing perceptions. Other researchers identified a satiation effect, which resulted from focusing on a picture or words with intense concentration. Eventually previous meaning dissolved, which opened the possibility for new perspectives. Creative people described a similar fixation on a specific melody when composing or a specific object when painting.

This process appears to break down previous belief systems, inhibiting cognition in favor of perception, in the same way that a Zen student must go through deconstruction of his or her belief system before arriving at enlightenment and a true understanding of the world. It is a shift in paradigms that links creativity and Zen.

A study indicated that meditation improved cognitive flexibility which in turn positively influenced creativity (Müller et al., 2016)

The ten year rule proposed by Chase and Simon in 1978 proposed that expertise takes ten years to achieve. The slow learning mentor-student relationship practiced by Zen teachers may be more effective in the long run than some Western techniques. Flow, defined as the feeling of an almost automatic, effortless, yet highly focused state of consciousness, is similar to descriptions of Zen creativity (See Flow).

Another aspect of Zen that could have application in creativity research is based on the concept of Beginners Mind (Shoshun). Shyunryu Suzuki explained this term in relation to meditation: "In the beginners mind there are many possibilities, but in the experts there are few" (p. 2, n.d.). The concept is consistent with the openness which researchers have proven is a personality characteristic of eminent creators. This openness is part of the novice effect proposed by Robert Root-Bernstein in which an insight usually occurs within the first ten years of an individual entering a field.

Kuhn's concept of Paradigm Shifts could be considered an example of Beginner's Mind – an historian approaching science from a different angle than working scientists. The concept of Beginner's Mind has potential implications for important areas of creativity such as problem finding and discovery.

Business and Sports

Zen training and ideas about creativity worked their way into mainstream thinking in Western society. Some American companies provided training in Zen meditation and principles in the 1970s and 1980s when Japanese businesses were thriving and American companies were struggling. Writers, consultants, and teachers gave advice about creative management using Zen principles, while others stressed meditation as a way to relieve stress. A recent meta-analysis of mindfulness meditation in the workplace looked at 23 studies in the workplace. The results indicate positive improvement in mindfulness, stress, anxiety and psychological distress (Bartlett et al., 2019).

In sports, *Zen and the Art of Archery* became a widely read influential book. Phil Jackson used Zen principles to coach his teams to more NBA titles than any coach in history. Tiger Woods is a Buddhist so now *The Zen of Golf* joined *The Zen of Tennis* on the bookshelf. And let's not forget *Zen and the Art of Windsurfing*.

Conclusion

Zen has influenced both the concept and execution of many different areas involving creativity, especially in Japan. The key aspects that Zen affected include the following:

1. The training for professions, which in many ways interacted and reinforced Zen principles. Each type of training became known as a way to enlightenment. A mentor–master teacher worked with students to make routine aspects automatic and as free of ego as possible. Once the ego was minimized, the mind and body were free so creativity could become natural and spontaneous.
2. An element of deliberate incompleteness that required the audience to use their own life experience to participate in the creative process. The viewer is part of the picture. Zen art is designed to be an experience grasped as a whole, not intellectually analyzed.
3. An appreciation of asymmetry and 'happy accidents' that produced distinctive products. The term *wabi* is used to describe the nobility of simplicity and rough edges of Zen products.
4. Increasing awareness and understanding by altering perceptions and forcing the mind to stretch.
5. Emphasis on the nonverbal with only a minimum of words even in haiku and No drama.

Zen art has touched upon almost every aspect of Japanese life and its presence is still felt today. Sensitivity to nature, the awareness of beauty, and the attention to the aesthetic details in life inherent in Japanese culture are a direct legacy of Zen creativity.

In the West, Zen influenced a variety of domains with a practical bent including writing, business, sports, and psychology. Creativity research incorporated the important concept of Beginner's Mind and Mindfulness.

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Notes

Cross-reference terms in *italics> are general cross-references, or refer to subentry terms within the main entry (the main entry is not repeated to save space).*

The index is arranged in set-out style with a maximum of three levels of subheading. Major discussion of a subject is indicated by bold page numbers. Page numbers suffixed by t, f, and b refer to Tables, Figures, and Boxes respectively. *vs.* indicates a comparison.

The index entries are presented in word-by-word alphabetical sequence in which a group of letters followed by a space is filed before the same group of letters followed by a letter. For example, entries beginning 'air density' are alphabetized before 'aircraft.' Prefixes and terms in parentheses are excluded from the initial alphabetization.

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